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A Study on the English Translation of Tourist Attraction Introductions from the Perspective of Eco-Translatology: A Case Study of Kulangsu

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Abstract

With the acceleration of globalization, tourism has become a vital bridge for international exchange, and the English translation of tourist attraction descriptions has become a pivotal window for foreign visitors to understand Chinese culture. The quality of English translations of tourist attraction introductions directly impacts foreign visitors' understanding and perception of Kulangsu, and, by extension, Chinese culture. From the theoretical perspective of Eco-translatology, this study focuses on the English translation of tourist attractions in Kulangsu and conducts an in-depth exploration. The research comprehensively uses case-analysis method to conduct a multi-dimensional analysis of the English-translated texts of tourist attractions in Kulangsu. Through analysis, it is found that under the guidance of Eco-translatology, translators need to make adaptive selections and transformations in the dimensions of language, culture, and communication to better achieve the translation purpose. This research is of great significance for tourism translation. It helps to improve the quality of tourism translation, promotes the effective transmission of tourism culture, and facilitates the international development of the tourism industry. At the same time, it also provides specific case support for the application of Eco-translatology in the field of tourism translation, enriching the theoretical and practical systems of Eco-translatology.

Keywords

Eco-translatology; Tourist attraction introductions; Kulangsu; Three-dimensional transformation

1. Introduction

With the rapid development of global tourism, the English translation of tourist attraction introductions has become a pivotal tool in enhancing destination international image and facilitating cross-cultural communication. Traditional translation studies, predominantly focusing on linguistic balance, overlooking the adaptability and functional realization of translations within target cultural ecology. Professor Hu Gengshen's Eco-Translatology reframes translation as an adaptive-selective activity undertaken by translators within a tri-dimensional ecological environment incorporating linguistic, cultural, and communicative dimensions, emphasizing three-dimensional transformation that is the synergistic interplay of linguistic, cultural, and communicative adaptation (Hu, 2025). This theoretical framework offers a systematic analytical model for the cross-linguistic spread of tourism texts.

In tourism texts, such as tourist attraction introductions, brochures, and guide narratives, these texts not only convey information but also fulfill functions of shaping visitor identity and publicizing regional culture. The study suggest that applying Eco-Translatology's three-dimensional transformation can achieve both semantic integrity and effective cultural connotation transmission, thereby enhancing translation reception and promotion efficacy (Wang, 2021). Integrating an ecological translation perspective into the English translation research of scenic spots thus serves as both a practical effect of translation theory and an innovative exploration of tourism promotion strategies.

This study takes Kulangsu as a case study for analysis. As a UNESCO World Cultural Heritage, Kulangsu has both profound historical cultural heritage and the distinctive characteristics of multi-ethnic habitation. The architectural style, music culture and community life fully demonstrate the unique charm of the integration of Chinese and Western civilizations. Based on the official tourist attraction introductions, this study uses the three-dimensional transformation analysis framework to systematically deconstruct the English translation process. At the theoretical level, promote the in-depth application and practical verification of ecological translation theory in the field of cross-cultural tourism translation. At the practical level, it provides an methodological reference for optimizing the cross-cultural communication strategy of cultural heritage in the context of global tourism development. In view of the international popularity of Kulangsu, the translation of its tourist attraction introduction needs to accurately convey historical value and cultural connotation. So the major target of this study is to explore the practical path of Eco-Translatology, providing new ideas and expanding related research.

2. Theoretical Framework

"Eco-Translatology focuses on the holistic nature of the translation ecosystem. From the perspective of Eco-Translatology and using its narrative approach, it provides new descriptions and explanations for the essence, processes, criteria, principles, and methods of translation, as well as translation phenomena" (Hu, 2008). In recent years, Eco-translatology has become an emerging translation theory with Chinese characteristics and adapted to the needs of the times (Wang, 2023). This innovative translation theory is inspired by ecological principles. Eco-translatology offers a fresh theoretical framework for translation studies, emphasizing the notions of adaptation and selection in the translation process. It puts forward multidimensional translation principles and a three-dimensional transformation approach, aiming to achieve ecological balance and harmony between the source text and the target text.

The core premise of Eco-translatology is the analogy between the translation ecosystem and natural ecosystems. Just as organisms must adapt to their environment to survive, translations must adapt to the target cultural and communicative environment to be effective and accepted (Hu, 2008). As the core subject of this process, translators need to continuously make adaptive choices based on the translation context. This perspective breaks the limitations of pure linguistic translation and examines translation activities from a broader socio-cultural perspective, highlighting the contextual embeddedness and sociocultural relevance of translation practice.

2.1 Three-dimensional transformation

Eco-translatology views translation as a process of adaptation and selection by translators within a diverse ecological environment, where the three-dimensional transformation serves

as the core method to achieve this goal. The three dimensions of translation are the linguistic dimension, cultural dimension, and communicative dimension. Translators must make adaptive choices along these three parallel dimensions to achieve the overall balance of the target text (Hu, 2013).

The linguistic dimension refers to the translator's ability to make adaptive choices and transformations in vocabulary, grammar, sentence structure, language style and other aspects according to the translation environment during the translation process. This is done in order to achieve a balance between the source text and the target text and ensure that the translated text accurately conveys the meaning of the source text. The cultural dimension concerns the cultural connotations, values, and social contexts behind language. Translators need to decode the symbolic system of the source culture and find equivalent or acceptable expressions in the target culture to ensure that the target text conveys the cultural implications of the original. This dimension is particularly crucial in tourism translation, where place names, historical figures, customs, and artistic expressions are deeply embedded in the local culture. Failure to adequately address cultural differences may result in significant misunderstandings and the loss of cultural significance. Strategies such as transliteration, annotation, cultural substitution, or explanatory translation are often employed to bridge cultural gaps. The communicative dimension emphasizes the communicative function and purpose of translation. Translators must consider the audience's cognitive needs, communicative situations, and the functional realization of information to ensure that the target text achieves the expected effect in practical communication (Wang & Tang, 2023). In tourism texts, the primary communicative purpose is often to inform, attract, and persuade potential visitors. Therefore, translations must be reader-friendly, engaging, and tailored to the expectations and background knowledge of the international tourist. This involve simplifying complex historical narratives, highlighting universally appealing features, or restructuring information for clarity and impact.

These three dimensions are not isolated, they are interconnected and overlap. A decision in one dimension inevitably affects the others. The ultimate goal of the three-dimensional transformation is to achieve a state of "ecological balance" where the translated text harmoniously integrates into the target language and cultural environment, fulfilling its intended communicative function while preserving the essential meaning and cultural spirit of the original (Luo, 2024).

2.2 The Significance of the Theory in the Translation

"Tourism translation is a communicative activity involving language, society, culture, and psychology" (Chen, 2004). The application of Eco-translatology in the context of tourist attractions is of great significance and value. It can not only enhance the internationalization level of tourist attractions, facilitating cross-cultural communication, but also improve the understanding and identification of target language readers with the original culture. Eco-translatology emphasizes the significance of preserving ecological balance and making adaptive choices in the translation process, prompting translators to thoroughly consider the cultural background, aesthetic preferences, and linguistic conventions of the target readers. Therefore, in the process of translating tourist attraction materials into English, Eco-translatology should be fully referenced and applied to achieve better translation and cultural communication effects.

The theory's significance extends beyond practical translation strategies. It provides a philosophical and methodological foundation for tourism translation. By framing translation as

an ecological process of adaptation and selection, it empowers translators to make informed, holistic decisions that balance to the source text with functionality in the target context. This is especially important in an era of globalized tourism, where the accurate and appealing representation of cultural heritage can have significant economic and soft-power implications. Eco-translatology as a theory developed in China, offers a new perspective in the field of translation studies.

3. Case Analysis

3.1. Linguistic dimension

"In the expression of language, the forms is different. Language form mainly includes two aspects, one is whether the word is accurate, the other is whether the syntax is appropriate" (Shang, 2017). The linguistic dimension necessitates that translators make adaptive choices at the levels of vocabulary, syntax, and discourse to ensure the accuracy, fluency, and conformity of the target text to the conventions of the target language.

3.1.1 Translation of vocabulary

ST: 日光岩；龙头山；凌空屹立；浑然天成

TT: Sunlight Rock; Loong Head Hill; Standing aloft; Natural masterpiece

In translating the names " 日光岩 " and " 龙头山 " from the source text, efforts were made to retain the cultural characteristics while ensuring comprehension for target language readers. " 日光岩 " was directly rendered as "Sunlight Rock" maintaining its literal meaning. In contrast, " 龙 头 山 " is an transliteration, translated as "Loong Head Hill," where "Loong" serves as a phonetic translation of "long" (龙), conveying the imagery of Chinese culture. This choice of "Loong" over "Dragon" is deliberate, as "Dragon" in Western culture carries connotations of evil, whereas Loong in Chinese culture symbolizes auspiciousness. It not only preserves cultural elements but also facilitates cultural spread, reflecting cultural self-confidence and bringing the balance of the culture. This approach to translating culturally specific terms demonstrates a keen awareness of the cultural dimension even within the primary focus on linguistic form.

Expressions like " 凌空屹立 "and " 浑然天成 " in the source text regarding Sunlight Rock are rich in symbolic meanings, expressing people's love and affection for it. In translation, " 凌空屹立 " was translated as "standing aloft", incorporating a touch of personification, which adds a dynamic and majestic quality to the description. " 浑然天成 " was conveyed as "Natural masterpiece", highlighting the uniqueness and natural grandeur of Sunlight Rock. This translation elevates the rock from a mere geological formation to a work of art, effectively communicating its perceived perfection and aesthetic value. In the process of translation, the translator needs to ensure the accuracy and fluency of the target text at the linguistic level. This embodies the preservation and transformation of cultural elements, while emphasizing on the accurate expression of the source text, achieving ecological balance, and restoring the original artistic conception. The choice of "masterpiece" is particularly effective as it resonates with artistic traditions, making the description more relatable to the target audience.

3.1.2 Translation of sentence

ST: " 是宫非宫胜似宫，亦殿非殿赛过殿；不中不洋不寻常，中西结合更耐看。"

TT: “It surpasses the grandeur of a palace, but it is not a true palace. It transcends the glory of the hall, but it is not just a hall. It has a unique and incredible style, neither wholly Chinese nor entirely Western, and the blend of Chinese and Western elements gives it eternal charm.”

The example illustrates a complex syntactic adaptation. The source text is a parallel couplet, a common rhetorical structure in Chinese, characterized by symmetry, rhythm, and conciseness. Translating word for word is likely to result in stiff and incomprehensible English expressions. The translation adopts a sentence structure combining parallel and complex sentences, which not only maintains the sense of hierarchy and logic of information, but also facilitates readers’ understanding and acceptance. In Eco-translatology, the adaptability of this sentence structure allows it to flexibly convey the information of the source text while conforming to the reading habits and thinking patterns of target language readers. In addition, the description of architecture utilizes contrasting rhetorical devices, such as “surpasses…but is not” and “transcends… but is not”. By contrasting the grandeur of palaces to emphasize the extraordinary of villas, this approach accords with the linguistic aspect, enhancing the expressive force of language and making the information more vivid and specific.

This highlights the feature of the blend of Chinese and Western elements. It also applies the amplification to add information that is not present in the source text but can be inferred from the discourse, such as “eternal charm,” which captures the enduring appeal implied by “ 更耐看 ”. This strategic serves the communicative purpose of persuading and attracting visitors.

3.1.3 Translation of discours

ST: 该建筑受到英国维多利亚时期绚丽红砖建筑的影响，也与闽南红砖红白相间的装饰色彩相似。建筑外立面的浮雕装饰中有来自中西文化的不同题材，非常丰富有趣，据说始建时还塑有女王头像。庭院内园林的设计与处理手法也体现出中西合璧的特征，其中有仿西式的院门、西侧院墙上的中式如意漏窗和按中国传统造园手法设置的假山，而假山的形式却与欧洲巴洛克园林中模仿自然溶洞的假山相似。

TT: This building is influenced by the magnificent red brick architecture of the Victorian era in England, and is also similar in color to the red and white decoration of Minnan red bricks. The relief decoration on the exterior facade of the building features different themes from Chinese and Western cultures, which are rich and interesting. It is said that when it was first built, there was also a sculpture of the queen’s portrait. The design and treatment of the garden within the courtyard also reflect a fusion of Chinese and Western styles, including a Western-style gate, Chinese-style Ruyi lattice windows on the west courtyard wall, and rockeries set according to traditional Chinese garden design techniques. Yet, the form of the rockeries is similar to those in European Baroque gardens that imitate natural caves.

At the discourse level, the translation successfully maintains the cohesive and coherent flow of the original description. The text integrates descriptions of architectural terms and styles in both Chinese and English, reflecting the diversity of language. The fusion of Chinese and Western cultures is applied through the use of terms such as “Victorian era” and “Minnan red bricks”, achieving a balance between Chinese and Western culture. The translator makes conscious choices to retain culturally specific terms like “Ruyi lattice windows” and “rockeries,” enabling that the context will provide sufficient clues for understanding, or that the exotic terms themselves add to the cultural appeal.

The text utilizes rhetorical devices such as contrast and analogy, which enhance the text appeal and persuasiveness. For instance, by contrasting the decorative colors of Victorian-era red

brick architecture in England with Minnan red brick buildings, the unique color application of the building is highlighted. And by analogizing the rockeries within the courtyard to those in European Baroque gardens, the clever blend of Chinese and Western garden design techniques is showcased. These rhetorical devices not only enrich the expression of the text but also allow readers to visually experience the cultural charm and artistic value of the architecture. The translation of the Chinese and Western architectural styles and garden designs is artfully blended, creating a harmonious linguistic ecology. This harmony is reflected in the respect and integration of Chinese and Western cultures, allowing the text to convey information while exhibiting a beauty of harmony. Through adaptive choices in vocabulary selection and rhetorical techniques, the balance of the text within the translation's ecological environment is maintained. The discourse paints a vivid picture for the reader, fulfilling the communicative function of helping them visualize and appreciate the unique architectural landscape of Kulangsu.

3.2. Cultural dimension

The cultural dimension is paramount in tourism translation, as it deals with the transmission of unique cultural elements that form the core of the tourist experience.

3.2.1 Translation of proper noun

ST: 郑成功巨型石雕、郑成功青铜群雕、郑成功碑廊、覆鼎古井、皇帝殿，合称 “皓月雄风”。

TT: Stone Statue of Zheng Chenggong (a famous general and national hero in Chinese history), Zheng Chenggong's Bronze Sculptures, Zheng Chenggong's Tablet Gallery, Fuding Ancient Well and Emperor's shrine, collectively known as "Haoyue (symbolizing purity, nobility and patriotic) Spirit".

The sentence involves the translation of proper nouns. In order to achieve the balance of cultural dimension, the translator can choose to add the annotation to reflect the cultural connotation of the source text (Mu, 2022). This is a crucial strategy for bridging the cultural knowledge gap. For the "Stone Statue of Zheng Chenggong (a famous general and national hero in Chinese history)", the necessary cultural background information is provided for the target language readers through the annotation in parentheses. This reveals Zheng Chenggong, a figure of historical significance, enabling international visitors to appreciate the monument's significance. "Bronze Sculptures" directly conveys the material and artistic form of the sculptures, while "Tablet Gallery" accurately describes a place for displaying inscribed tablets. Meanwhile, "Zheng Chenggong's" clarifies the association between these sculptures and Zheng Chenggong.

The word "Shrine" in English typically refers to a sacred place for the worship of deities or saints. Here, it is used to translate "the emperor's hall" or "the emperor's ancestral temple", which may not correspond to all the meanings of "palace" or "ancestral temple" in Chinese, but in terms of cultural dimension, it conveys that the building is associated with the emperor and possesses a certain sanctity. This is an adaptive choice that finds a functional equivalent in the target culture. The translation of "Haoyue Spirit" effectively conveys the multiple cultural connotations of "Haoyue" in Chinese through the explanation provided in parentheses (symbolizing purity, nobility and patriotic). The transliteration method is used for "Haoyue", preserving its phonetic character. This method not only preserves the poetic and symbolic meaning of the source text but also helps target language readers better understand the cultural implications contained in this compound noun through explanations. For the translation of

proper nouns, the transmission of cultural information was enhanced by adding explanations in parentheses and using transliteration so that the understanding of the targeted readers. The translator serves as a cultural mediator, ensuring that deep cultural values are not lost in translation.

3.2.2 Translation of cultural-loaded words

ST: 四落大厝；红砖厝；风水理念；功夫茶

TT: Four-Courtyard Complex; red brick houses; Fengshui principles(an ancient Chinese theory of environmental selection and architectural planning); Kung fu tea

Cultural-loaded words present a significant challenge because they contain concepts unique to the source culture. The word " 厝 " in Fujian local dialect refers to the meaning of "house". "Four-Courtyard Complex" is a translation that combines phonetic and free translation, retaining the characteristic word " 四落 " while conveying the complexity and scale of the architectural group through "Complex". This translation gives the structure a distinct identity compared to a general "house". "Red Brick Houses" directly and clearly convey the main material and color characteristics of the buildings, in line with the principles of cultural adaptation in Eco-translatology, providing immediate recognizability. "Fengshui principles" uses a combination of phonetic translation and annotation, preserving the uniqueness of the Chinese term while explaining its cultural connotation through explanation in the parentheses. This translation strategy aids target language readers to further explore the cultural significance behind the concept after understanding the basics. It acknowledges that "Fengshui" has entered the global lexicon but still requires contextualization for full understanding. "Kung fu tea", though phonetically translated, has become a widely accepted and used term in international tea culture to specifically refer to this tea art. The translation method not only conveys the essence of tea art but also promotes the exchange and transmission of tea culture between China and other countries. Through strategies such as deeply understanding cultural connotations, selecting appropriate translation strategies (phonetic translation, free translation, annotation), and maintaining cultural ecological balance, an ecological balance for culture-loaded words in the translation environment was achieved. The translator selectively integrates source culture terms into the target text, enriching it without compromising understanding.

3.3. Communicative dimension

The communicative dimension focuses on the intended effect of the translation on the target reader, ensuring the text fulfills its informative and persuasive functions.

3.3.1 Translation of four character words

ST: 一览无遗；闻名遐迩；中西合璧

TT: the scenery appear in its entirety, nothing is hidden from view; a wide reputation; a unique fusion of Chinese and Western aesthetics

As an important part of China's excellent traditional culture, four-character phrases reflect the breadth, depth and rich cultural connotation of Chinese civilization. The translation of "the scenery appear in its entirety, nothing is hidden from view" effectively captures the essence and visual experience of the source text through descriptive language. Free translation is utilized. It employs a complete sentence structure to convey poetic imagery and a sense of

panoramic beauty, prioritizing clarity and descriptive power over conciseness. “A wide reputation” is a brief and direct translation that quickly conveys the core meaning, allowing target language readers to grasp the essential information promptly. The omission of the more florid connotations of “ 闻名遐迩 ” is applied to avoid rigidity and maintain readability. “A unique fusion of Chinese and Western aesthetics” aptly expresses the distinctive blending of Chinese and Western aesthetic ideals. The use of “fusion” underscores the integration of these two cultural elements, while “aesthetics” specifies that this fusion occurs at the level of artistic appreciation. This translation facilitates target readers’ understanding of the cultural influence and aesthetic value inherent in the source text. The translator prioritizes the communicative goal of clear understanding over a literal rendering of the four-character structure. In the context of communication, translating four-character words need focusing on it central meanings directly, to achieve the goal of clear cross-cultural communication. The aesthetic form is adapted to meet the functional and stylistic expectations of the target language.

3.3.2 Translation of parallel phrases

ST: 园内看海，波浪拍岸，依栏远眺，极尽山海之致，复有岩洞之幽；鲜花满径，绿树成行，为难得之胜景。

TT: Looking out at the sea from inside the garden, one can see the waves lapping against the shore. Standing by the railing and gazing into the distance, one can fully enjoy the mountain and sea vistas, as well as the serenity of the caves. The garden is lined with paths full of flowers and rows of green trees, making it a rare and beautiful scenic spot.

The source text is a classic example of parallel structure in Chinese scenic description, creating a rhythmic and cumulative depiction of beauty. The series of short, vivid phrases paints a panoramic and sensory picture. A literal translation might read like a disjointed list. The translation skillfully adapts this structure into coherent, flowing English sentences. It breaks the sequence into logical syntactic units while preserving the original’s descriptive richness.

The expressions such as “the waves lapping against the shore” and “ one can fully enjoy the mountain and sea vistas, as well as the serenity of the caves” not only accurately convey the natural scenery described in the source text but also preserve the emotional color and atmosphere through delicate description. It enables readers to experience similar emotions when reading the translation as they would in reading the original. The use of present participles (lapping, looking, standing) and descriptive clauses creates a sense of immediacy and immersion. Meanwhile, “The garden is lined with paths full of flowers and rows of green trees” successfully retains the cultural imagery found in the source text, allowing readers to comprehend and appreciate the beautiful connotations conveyed by this imagery. This preservation and transformation of cultural imagery facilitates communication and understanding between different cultures. The source text utilizes a series of parallel phrases to showcase a beautiful, serene, and vibrant natural landscape, evoking readers’ yearning and admiration for the scenery. In the translation, it achieves the communicative intention of the source text to attract and captivate the visitor through precise translation and appropriate language expression. The last sentence, “making it a rare and beautiful scenic spot,” explicitly states the evaluative conclusion, which is implicit in Chinese texts, thereby making the promotional purpose clear to the international reader. This communicative intention is a crucial indicator of achieving ecological balance between the original text and the translation on the communicative dimension. The translation is not merely a semantic transfer but a re-creation of the reader’s experience.

4. Conclusion

This paper studies the translation practice issues of tourist attraction introductions on Kulangsu, based on the three-dimensional transformation principle of Eco-translatology. It is found that the translation of tourist attraction introductions should adhere to the principles of adaptability and balance. This involves flexible strategies such as syntactic restructuring, the use of annotations, cultural substitution, and functional equivalence. The balance principle underlines the importance of an ecological balance between the source and translated texts across linguistic, cultural, and communicative dimensions during the translation process. And it is not a rigid equivalence but a dynamic one, where offsets in one dimension are made to achieve gains in another.

Tourism texts contain cultural background information, highlighting the importance of cultural adaptability. Translation strategies, including transliteration, free translation, and omission, can be flexibly employed to eliminate cultural barriers and ensure a more accurate conveyance of the original meaning. The case of Kulangsu demonstrates a successful translation. It allows the international visitor to not just "see" the sights but to "understand" and "appreciate" their cultural significance.

This study also demonstrates its practical utility, thereby enriching research on the translation of tourism texts and expanding the research field of Eco-translatology. To a certain extent, it also contributes to the spread of outstanding Chinese culture and promotes the development of the tourism industry. In the future studies, the research and application of the theory of Eco-translatology can be delved into more deeply, with a continuous improvement of its theoretical system and practice being undertaken in the field of tourism translation.

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The author(s) declare no conflicts of interest regarding the publication of this paper.

Ethics Statement

Not applicable.

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Chinese Undergraduate English Majors' Perceptions of Mobile-Assisted Language Learning for Deep Vocabulary Development: A Qualitative Inquiry

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Abstract

Mobile-assisted language learning (MALL) has transformed English vocabulary acquisition among Chinese learners, yet questions persist regarding its effectiveness in facilitating deep vocabulary learning beyond surface-level word recognition. This qualitative case study investigates Chinese undergraduate English majors' perceptions of MALL's capacity to support deep vocabulary development. Using purposeful criterion sampling, four second-year English majors from a private college in China who experienced vocabulary learning challenges and regularly used MALL applications participated in semi-structured interviews. Data were systematically analyzed through NVivo software employing grounded theory principles. The coding process revealed three core themes: (B1) English vocabulary learning experience; (B2) use of mobile applications; and (B3) impact on learning changes and skill improvement. Findings indicate that while MALL applications effectively expand vocabulary breadth through features such as picture hints, multimedia resources, and spaced repetition, participants identified challenges in developing vocabulary depth. Specifically, learners struggled to transfer app-based knowledge to authentic communicative contexts, experienced tension between initial motivation and sustained engagement, and found limited support for understanding collocations, pragmatic constraints, and semantic networks. The study reveals that current MALL implementations more effectively support "shallow breadth" than genuine depth, underscoring the need for theoretically grounded pedagogies that explicitly address deep processing, metacognitive development, and contextualized practice to ensure meaningful, sustainable vocabulary acquisition..

Keywords

Mobile-assisted language learning; Deep vocabulary learning; Learner perceptions; Chinese EFL learners; Qualitative case study

1. Introduction

The advancement of the internet has profoundly changed how people live. Exchanging information via mobile phones is becoming ubiquitous due to its accessibility and feasibility of worldwide communication, which enhances the needs of learning English as an internationally universal language. Under this background, it is by no means uncommon for Chinese students

to learn English vocabulary with the help of their mobiles.

Learning tools of English vocabulary have shifted from the traditional hard copy dictionary, word books and electronic dictionaries, to learning applications on mobile phones such as Shan Bei, Bai Ci Zhan and Bu Bei Dan Ci. Being accessible, instant, and interactive, they are also easy to carry, and facilitate the recording and management of learning. Therefore, mobile assisted language learning (MALL) has drawn wide attention in the field of English learning and teaching. Ideally, MALL should help learners build systematic vocabulary knowledge, thereby enabling them to apply it practically to meet the demands of real-world English communication. However, there remains a gap in literature.

To address this critical gap, the present study investigates Chinese undergraduate English majors' perceptions of MALL's effectiveness in facilitating deep vocabulary learning. Specifically, this research examines whether mobile applications can transcend their current role in vocabulary expansion to support deeper cognitive processes including knowledge integration, systematic organization, and practical application of vocabulary. By exploring learners' lived experiences with MALL tools, this study seeks to illuminate the tensions between convenience and depth, fragmentation and coherence in mobile-assisted vocabulary learning. Understanding these dynamics is essential for optimizing MALL pedagogies and ensuring that technological affordances translate into meaningful learning outcomes rather than superficial engagement with decontextualized word lists.

2. Literature Review

Mobile-Assisted Language Learning (MALL) has emerged as a significant pedagogical approach in contemporary English language education, fundamentally transforming how learners engage with vocabulary acquisition. Kukulska-Hulme and Traxler (2005) provided foundational insights into MALL by defining it as language learning supported by mobile devices, emphasizing its inherent characteristics of portability, immediacy, and contextual learning opportunities. Building upon this groundwork, contemporary research has increasingly demonstrated MALL's capacity to create ubiquitous, personalized, and interactive learning environments that transcend traditional spatial and temporal constraints (Li, 2024; Zhang et al., 2024).

Substantial empirical evidence demonstrates MALL's positive impact across multiple dimensions of language learning. Studies examining speaking performance (Pebiana & Febria, 2023), grammar acquisition (Jais et al., 2022), and listening skills (bin Noordan & Yunus, 2022) collectively illustrate MALL's versatility in supporting diverse linguistic competencies. Particularly relevant to the current study, research on Chinese EFL learners reveals compelling patterns. Lu et al. (2023) conducted a quasi-experimental investigation with 108 Chinese non-English majors, finding that students using a theory-based mobile app demonstrated a 129.65% improvement in vocabulary learning, which was significantly higher than the 68.4% gain observed in the control group. This finding underscore mobile applications' capacity to enhance both vocabulary achievement and retention among Chinese tertiary students.

Beyond effectiveness studies, researchers have systematically examined factors influencing learners' acceptance and sustained use of MALL technologies. Studies employing the Technology Acceptance Model (TAM) have established that perceived usefulness and ease of use serve as primary predictors of adoption (Tan & Hsu, 2018; Zhang & Hennessy, 2023). The Unified Theory of Acceptance and Use of Technology (UTAUT) model, as applied by Yee and

Abdullah (2021), provides additional explanatory power by considering contextual variables such as peer influence and teacher support. These external factors have been identified as significant motivators for MALL adoption, suggesting that successful implementation requires attention not only to app features but also to the broader social learning environment. This multifaceted understanding of technology acceptance informs more effective pedagogical integration strategies that account for both individual and contextual factors.

The evolution of MALL research methodologies reflects increasing sophistication in understanding how technology can optimize language learning. Contemporary researchers have adopted design and development research frameworks, particularly the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), to create evidence-based mobile learning interventions (Dağdeler et al., 2020; Muslimin et al., 2017; Alhuwaydi, 2022). This systematic approach ensures that mobile applications and modules align with established pedagogical principles while addressing specific learner needs. Li (2024) conducted an extensive review of English vocabulary learning apps designed for Chinese EFL learners, analyzing their theoretical underpinnings and pedagogical frameworks. This analysis revealed that effective apps integrate vocabulary learning strategies with sound instructional design principles, including spaced repetition algorithms, multimodal input, contextualized practice, and immediate feedback mechanisms.

Despite extensive research documenting MALL's effectiveness for vocabulary expansion, a significant theoretical and empirical gap persists regarding its capacity to support deep vocabulary learning. Vocabulary breadth—the number of words known—has been the predominant focus of MALL research, with numerous studies confirming mobile tools' efficacy in enhancing learners' word recognition and basic comprehension (Koleini et al., 2024; Xodabande et al., 2023). However, vocabulary depth—encompassing nuanced understanding of word meanings, collocations, morphological properties, and pragmatic usage—remains under-explored in the MALL literature (Boroughani et al., 2023).

Current evidence suggests that mobile learning environments, while convenient and accessible, may inadvertently promote surface-level engagement. The design of many popular vocabulary apps prioritizes rapid recognition and de-contextualized memorization over deeper semantic processing and integration (Li, 2024). Research on information redundancy and learning fragmentation in mobile contexts reveals that learners often struggle to move beyond isolated word knowledge toward systematic vocabulary organization and practical application (Wagner-Loera, 2016). This tension between MALL's affordances for breadth and its potential limitations for depth represents a critical area requiring investigation.

In synthesis, while MALL research has established mobile technologies' efficacy for vocabulary expansion and documented factors influencing technology acceptance, critical gaps remain. Most significantly, there exists insufficient understanding of whether and how MALL can transcend its current role in vocabulary breadth development to support deeper cognitive processes including knowledge integration, systematic organization, and practical application. For Chinese undergraduate English majors navigating dense curricular demands, the capacity to leverage mobile tools for substantive rather than superficial vocabulary learning holds particular importance.

This study addresses these gaps by investigating learners' lived experiences with MALL vocabulary applications, specifically examining their perceptions of mobile learning's impact on vocabulary depth, organization, and meta-cognitive development. By foregrounding learners'

perspectives, this research seeks to illuminate the tensions between convenience and depth, fragmentation and coherence that characterize mobile-assisted vocabulary learning. Understanding these dynamics is essential for developing pedagogical approaches that harness MALL's affordances while mitigating its potential limitations, ultimately ensuring that mobile technologies serve as catalysts for meaningful, transformative language learning rather than merely facilitating surface-level engagement with decontextualized word lists.

3. Methodology

This study employs a qualitative research methodology using a single case study design. The participants were second-year English majors at a private college in China. This type of city-level private institution typically enrolls students with a lower English proficiency base compared to national key universities, thus representing a suitable context for investigating vocabulary learning challenges and the potential of MALL to address them. As Burns (1997) notes, case studies must focus on bounded subjects that are either highly representative or distinctively atypical; this setting satisfies both criteria as private colleges constitute a substantial portion of China's higher education system while also presenting unique pedagogical contexts.

A purposeful criterion sampling strategy was employed to ensure participant relevance. Selection criteria included: (1) second-year English majors with at least one year of college-level English instruction; (2) students experiencing challenges in deep vocabulary learning; and (3) learners with more than six months of experience using MALL applications. Four participants (two female, two male) were selected to achieve gender balance while maintaining a manageable sample size appropriate for in-depth qualitative inquiry. As Kumar (2018) emphasizes, purposeful sampling prioritizes information richness over sample size, targeting participants who possess relevant experiences and can articulate meaningful insights regarding the research phenomenon.

Data collection utilized semi-structured interviews designed to elicit participants' perceptions of MALL's effectiveness for deep vocabulary learning. This method provided sufficient flexibility to explore emergent themes while maintaining focus on core research questions. Interview protocols (see Appendix) guided discussions covering participants' MALL experiences, perceived impacts on vocabulary depth and organization, and meta-cognitive awareness. Follow-up questions were adapted based on participant responses to enable deeper exploration of significant themes. Ethical protocols were strictly observed: participants provided informed consent, were assured of anonymity, and understood their right to withdraw at any time.

Data analysis was performed using NVivo, a qualitative data analysis software rooted in grounded theory which is widely used in the fields of education, sociology, and psychology. It is suitable for processing large amounts of data such as text, audio, and video, and supports researchers in pattern recognition, theme discovery, and theory construction. The use of NVivo can improve the accuracy and credibility of research and provide a scientific basis for theory building and practice in related fields.

The purpose of using NVivo is as follows: first, NVivo provides a convenient platform to help researchers sort, classify, and label the collected interview texts for better data management and organization. Second, NVivo's analytic tools can help researchers discover patterns, themes, and relationships in many interview texts. In addition, NVivo supports the coding and comparison of texts, which helps to construct theoretical frameworks and explain factors and influences in the transformation process. Finally, NVivo provides visualization tools, such as

hierarchical charts and word clouds, to visualize the analysis results. The following section details the data collected from the study and provides the subsequent analysis of the results.

4. Results and Findings

The analysis of interview data followed a systematic three-stage coding process grounded in established qualitative research principles. This iterative approach allowed for progressively deeper understanding of participants' perceptions and experiences with mobile-assisted vocabulary learning. The following subsections present the coding outcomes at each analytical stage, demonstrating how raw interview data was systematically transformed into meaningful conceptual categories that illuminate the research questions.

4.1 Coding results

The coding process began with open coding, which served as the foundation for subsequent analytical stages. This initial phase involved careful examination of interview transcripts to identify meaningful units of information and assign preliminary conceptual labels. Through this systematic process, patterns and themes gradually emerged from participants' narratives about their mobile vocabulary learning experiences. The open coding phase generated a comprehensive set of initial categories that captured the diverse aspects of participants' perspectives, as detailed below.

4.1.1 Open coding results

Open coding is a method of extracting useful information from raw data, which helps the researcher to better understand and analyze the data and categorize it. The coder needs to consider the possibilities thoroughly, read the textual context carefully, and analyze the raw information and its abstract concepts. In this study, four interviews were coded using NVivo 12.0 software during the open coding phase, and a total of 28 reference points were created and seven initial categories A1 to A7 were extracted, as shown in Table 1.

Figure 1 Summary of open code indicators

Coding	Conceptualizing nodes	Original text	Initial scope
a1	dictate and recite	In high school, the vocabulary required to be mastered by the courses we take has also increased dramatically, and most of the vocabulary is memorized by a combination of dictation and memorization.	A1: learning styles
a2	morphological memory	For example, use learning apps to access the roots and properties of words, as well as the origin stories of some words, so that situational memorization is beneficial to your own learning.	
a3	everyday language	Start with the simplest English vocabulary, which mostly relates to fruits, colors and simple greetings.	
a4	grammar learning	When we enter middle school, we learn English in depth and begin to learn basic grammar.	
a5	phonetic symbols learning	Teachers begin to teach English phonetic symbols in fourth grade.	

a6	APP pictures	I first started to use mobile apps to memorize words in high school during this period, and I started to use Bai Ci Zhan and Baidu Translator to learn, and Bai Ci Zhan has pictures to memorize very quickly.	A2: learning resources
a7	movie songs	I usually like to watch some movies and listen to some English songs to make the vocabulary more memorable in the melody.	
a8	apps search	It was also at this stage that I learned to use the vocabulary apps more frequently to look up vocabulary, and without realizing it, I developed the habit of actively learning new words.	
a9	massive resources	These mobile vocabulary learning apps include a wide range of common dictionary content you'd find in a bookstore, and it's easy to access different versions.	A3: advantages
a10	soundtracks	However, most of the mobile vocabulary learning apps come with example sentences and original voice readings, in which case it really does have the sound, shape and meaning.	
a11	content attraction	I think another great strength of mobile vocabulary learning apps is having more granular and engaging learning content.	
a12	audio sample sentence	Mobile vocabulary learning can be accompanied by listening practice, as most learning apps come with plenty of example sentences and audio on each.	
a13	self-testing	The next day, when you log in to study and review, you'll also find some self-testing features right there in the interface.	
a14	expanding vocabulary	To learn vocabulary in a mobile vocabulary learning program, I want to expand my vocabulary and have a long-term memory.	A4: purposefulness
a15	correcting pronunciation	I can correct my mispronunciations with the pronunciation feature.	
a16	inferring semantics	Hope to be able to infer the meaning of words according to the context and relate to the context.	
a17	grammatical collocations	Through the vocabulary learning apps, you can learn more useful words and phrases, master their usage and collocation.	
a18	scenarios	In this way, I can also improve my English proficiency and better cope with various English learning and application scenarios to realize effective communication.	
a19	speaking practice	The learning apps also focuses on oral communication, which is more conducive to the overall learning of a language.	
a20	look up words and solve meanings	It also supports the functions of each translation and correction, effectively helping to improve listening, reading and writing together.	A5: experience and feelings
a21	supervised punching	Just set a reminder in the app's settings, and it will supervise us to learn the words and improve our own initiative.	
a22	annotation support	It also supports the functions of translation and correction, effectively helping to improve listening, reading and writing at the same time.	
a23	regular memory consolidation	I will use the apps's regular review feature to review words and reinforce my memory.	A6: changes to learning
a24	improve memorization methods	Some learning programs also introduce a punch card function, which can help monitor yourself and form a habit.	
a25	formation of access habits	Whenever I come across a new word, I will want to check its meaning, thus forming the habit of checking for new words!	

a26	builds writing vocabulary	In terms of writing, the apps allow you to accumulate a lot of advanced vocabulary and agree on replacement phrases.	A7: skills improvement
a27	increase learning fun	Some of them are adapted from movie and TV drama works or the lyrics just increase the fun of memorization.	
a28	improve reading quality	Instead, you know how to read through reasonable speculation and in context, thus greatly improving the quality and experience of reading .	

4.1.2 Spindle coding results

Spindle-based coding is the second stage of the coding process. In order to better understand the initial categories obtained by open coding, their attribute characteristics and interrelationships need to be analyzed in depth and constantly compared and analyzed. By following certain logical relationships, the initial categories can be further categorized to form more abstract main categories. Finally, the main category of the second stage is given a name. The main axial coding process in this study formed seven main categories, B1 to B3, as shown in Table 2.

Table 2 Summary of spindle-type coding indicators

Spindle coding	No. of reference points	Open coding	No. of reference points
B1: English vocabulary learning experience	8	A1: learning styles	5
		A2: learning resources	3
B2: use of mobile applications	15	A3: strengths	5
		A4: purpose	7
		A5: experiences and feelings	3
B3: impact	6	A6: changes to learning	3
		A7: Skill improvement	3

4.1.3 Selective coding results

Selective coding is the final step in the coding process. By analyzing the core categories, it is possible to organically link the initial categories with the main categories and verify the relationship between them. Eventually, based on the core categories, a mutually supportive and interrelated logical relationship is formed, which provides a complete idea and connotation for in-depth research. Based on the interviews in this study, the main categories were analyzed and summarized, and a conceptual model was established to provide a theoretical foundation for the excavation of "the effectiveness of mobile-assisted language learning in Chinese undergraduates' English vocabulary in-depth learning," as shown in Table 3.

Table 3 Summary of selectively coded indicators

Selective coding	Spindle coding	Open coding
C: Effectiveness of MALL on Deep Learning of English Vocabulary among Chinese Undergraduates	B1: English vocabulary learning experience	A1: learning styles
		A2: learning resources
	B2: use of mobile applications	A3: strengths
		A4: purpose
		A5: experiences and feelings
	B3: impact	A6: changes to learning
		A7: Skill improvement

4.2 Thematic analysis

4.2.1 Analysis of B1: English vocabulary learning experience

In terms of learning methods, a combination of dictation and memorization is used in order to memorize vocabulary. This method can improve the memorization and understanding of words and help learners apply these words better. Next is root word memorization. Learners use learning apps to access the roots and properties of words, as well as the origin stories of some words, to help learn through contextualized memory. By knowing what words are made of and where they come from, words can be better understood and memorized. Living words are also emphasized at the B1 level, as one participant indicates,

"in the Middle School Basketball program the focus is on practical instruction, starting with the simplest English vocabulary (S1)".

These words are mainly related to fruits, colors and simple greetings. Through practical scenarios, learners can better master English vocabulary commonly used in daily life. Moreover, in China, grammar learning begins at the middle school level when English learning gradually deepens, and learners begin to learn the basics of grammar. Hence,

"mastering the rules of grammar is very important for expressing and understanding English sentences correctly (S3)".

In addition, the following learning resources can be utilized at B1 level. The first one is app pictures. In the high school stage, participants begin to use cell phone app for word memorization. The first ones used are Bai Ci Zhan and Baidu Translate. The picture hints of Bai Ci Zhan help to memorize quickly, as one participant (S2) suggests,

"by looking at pictures to memorize words, you can understand and remember the meaning of words more vividly".

Next is multimedia resources such as movies and songs. By watching movies and listening to songs, it is beneficial for learners to improve their vocabulary by size. However, when it comes to depth of vocabulary knowledge, participants struggle to the actual use of vocabulary.

"Usually, I like to watch some movies and listen to some English songs. The melodies in movies and songs make the vocabulary easier to remember. But I honestly don't know how to use it. When I see it in different contexts, I get confused (S3)."

In summary, vocabulary learning at the B1 level can be enhanced by integrating multiple strategies. These include dictation, recitation, root memorization, learning life phrases and grammar, as well as utilizing multimedia resources such as pictures, movies, songs, and in-app query functions.

4.2.2 Analysis of B2: use of mobile applications

The vocabulary learning apps for mobile is widely organized, including common dictionary contents, which makes it convenient for users to access different versions of dictionaries, thus enjoying a huge number of resources. In this way, users can access more learning materials and enhance their learning effect. In addition, most of the mobile vocabulary learning apps are equipped with example sentences and original voice reading, so that users can really realize the learning effect of sound, shape and meaning. By hearing and imitating the standard pro-

nunciation, users can better master the correct pronunciation and usage of vocabulary. At the same time, the mobile vocabulary learning apps are equipped with more detailed and attractive learning content, which can attract users' attention. As stated,

"the rich graphic, audio and video materials, as well as interactive learning methods, make my learning process more vivid and interesting (S4)."

However, participants also reported difficulty sustaining such attention. As another participant noted,

"I sometimes lose interest too because it is always like this, and I don't think it's fun anymore (S2)".

At the same time, some mobile vocabulary learning apps also provide self-testing function, which allows users to review and test after learning.

"Through self-testing, I can know my learning errors in time and correct and consolidate them (S2)."

This indicates that built-in assessment tools can enhance students' metacognitive awareness regarding vocabulary learning by encouraging them to plan, monitor, and evaluate their progress. Another learning experience with the use of apps lies in that learners aim to expand their vocabulary size. Through systematic learning and practice, it is possible that learners gradually accumulate and firmly grasp more words and phrases. Meanwhile, with the pronunciation function of the mobile apps, students can correct their wrong pronunciation and improve their speaking ability and pronunciation accuracy. In addition, users want to infer the meaning of words through the context and deepen their understanding of the context, which facilitates the in-depth understanding of vocabulary, as noted by one participant,

"example sentences, and contextual situations are often provided in mobile apps to help me better understand the meaning and usage of vocabulary (S1)."

Through mobile vocabulary learning apps, users can learn more practical words and phrases, master their usage and collocations, so as to improve their language skills and avoid grammatical errors and improper collocations.

In addition, with mobile apps, learners can improve their English-speaking proficiency, better cope with various English learning and application scenarios, and realize effective communication. Whether in daily life, work or travel, students can flexibly use the vocabulary and expressions they have learned. Some learning apps also focus on oral communication, which is conducive to the overall learning of a language. Through simulated conversations, speaking practice and other functions, users can improve their fluency and self-confidence. The mobile apps also support various functions of translation and correction, effectively helping users to improve their listening, reading and writing skills. Users can always look up the interpretation and usage of raw words in the learning process to improve their vocabulary comprehension and application skills.

In addition, the reminder function in some apps supervises students to study vocabulary and improve their learning initiative. By setting the study plan and punch card function, users can better manage their study time and maintain their motivation. At the same time, the mobile apps also support various translation and correction functions, so that users can make annota-

tions, notes and exercises during the learning process to deepen their understanding and memory of the learning content. To summarize, the advantages and purposes of mobile vocabulary learning apps as well as users' feelings and experiences make mobile apps a powerful tool for learning vocabulary.

4.2.3 Analysis of B3: impact

There are multiple impacts that can be brought about by utilizing learning apps in learning. The first is learning transformation,

"with the help of apps, I can change the way and method of my learning. For example, through the function of regular consolidation of memory, I can utilize the apps to review words and thus consolidate memory (S3)."

In addition, some learning apps also introduce the punch card function, which can help monitor themselves and develop study habits. This also suggests that learning with mobile apps is conducive in developing students' meta-cognition.

Learning apps can not only have an impact on memorization and access habits, but also improve other learning skills. For example, in writing practice where advanced academic words and synonymous phrases are in need, learning apps can be used to accumulate these certain words and enrich writing process. Moreover, in terms of reading, with the help of apps students can not only understand the surface meaning of the text, but also read it through reasonable speculation and contextualization, thus improving the quality and experience of reading. However, some participants also reported doubts whether this effect can be long-term, as S4 claimed,

"I can feel my reading and speaking ability have improved, but I don't know if this can continue because I tend to forget these words as time goes by".

5. Discussion

This study investigated Chinese undergraduate English majors' perceptions of MALL's effectiveness in facilitating deep vocabulary learning. The findings reveal a nuanced picture that extends beyond simple affirmation of mobile technologies' utility, illuminating both the transformative potential and inherent limitations of MALL for supporting meaningful vocabulary development.

5.1 Contribution of MALL to vocabulary breadth and depth

The participants' experiences confirm that MALL applications effectively expand vocabulary breadth, aligning with meta-analytic findings by Teymouri (2024) and Boroughani et al. (2024) demonstrating superior vocabulary gains through mobile-assisted learning compared to traditional methods. However, the current study's more significant contribution lies in revealing how learners perceive MALL's capacity—or incapacity—to support vocabulary depth. Participants reported that while apps like Bai Ci Zhan and Shan Bei facilitate rapid word recognition and a grasp of basic definitions, they struggle to develop nuanced understanding of collocations, pragmatic constraints, and semantic networks that characterize deep vocabulary knowledge (Nation, 2013).

This finding resonates with Zhang et al.'s (2024) observation that Chinese EFL learners consulting mobile dictionaries predominantly focus on first-definition meanings and basic trans-

lations, neglecting the multidimensional aspects of word knowledge essential for productive language use. The pattern suggests a troubling disconnect: mobile technologies excel at delivering decontextualized information efficiently, yet this very efficiency may inadvertently reinforce surface-level engagement. As Li (2024) noted in analyzing Chinese vocabulary learning apps, many applications prioritize spaced repetition algorithms for memorization over contextualized practice and semantic integration—design choices that optimize breadth at the potential expense of depth.

Importantly, participants identified specific app features that either supported or hindered deep learning. Gamification elements, while motivating initial engagement (Shen et al., 2024), were perceived as sometimes trivializing vocabulary learning by reducing it to points and streaks rather than meaningful language acquisition. Conversely, features providing rich contextual examples, collocational information, and opportunities for productive practice were valued but reportedly underutilized due to time pressures and the apps' emphasis on rapid completion. This tension between convenience and depth emerged as a central theme, suggesting that MALL's affordances for ubiquitous, bite-sized learning may paradoxically constrain the sustained engagement necessary for developing robust vocabulary knowledge.

5.2 Self-regulation, motivation, and sustained engagement

The findings illuminate complex relationships among learner autonomy, motivation, and MALL effectiveness. Consistent with Han and Chen's (2024) research on Chinese EFL learners' acceptance of MALL applications, participants reported high initial motivation driven by perceived usefulness and ease of use. However, sustained engagement proved challenging, with participants describing cycles of intensive app use followed by abandonment—a pattern suggesting that MALL's motivational affordances may be more effective for initiation than maintenance.

This observation connects to broader questions about self-regulated learning in mobile contexts. Boroughani et al. (2023) found that mobile-assisted academic vocabulary learning enhanced university students' self-regulatory capacity when appropriately designed. The present study suggests that such benefits are not automatic but depend on apps incorporating metacognitive scaffolding, goal-setting mechanisms, and progress visualization that support learners in planning, monitoring, and evaluating their vocabulary development. Participants who demonstrated greatest satisfaction with MALL outcomes were those who had developed personal strategies for integrating app-based learning with other vocabulary acquisition activities—suggesting that MALL functions most effectively as one component within a broader, self-regulated learning ecology rather than as a standalone solution.

The motivational dimension also revealed tensions between extrinsic and intrinsic drivers. Drawing on Self-Determination Theory (Deci & Ryan, 1985), Chen and Zhao's (2022) research indicates that perceived autonomy, competence, and relatedness significantly predict mobile learning adoption. While MALL technologies inherently support autonomy through personalized, self-paced learning, participants in the current study reported that gamification and social comparison features sometimes undermined intrinsic motivation by shifting focus from meaningful language development to superficial achievement metrics. This finding suggests that MALL designers should carefully balance engagement mechanisms with authentic learning purposes to cultivate sustainable, internally motivated vocabulary development.

5.3 Bridging MALL and communicative competence

A recurring theme in participants' accounts was the perceived gap between app-based vocabulary knowledge and real-world language use. While participants acknowledged vocabulary expansion through MALL, some expressed uncertainty about whether this knowledge translated into improved speaking, writing, and comprehension abilities. This disconnect aligns with Lu et al.'s (2023) finding that while Chinese EFL learners achieved substantial vocabulary gains through theory-based mobile apps (129.65% increase), questions remain about the durability and transferability of such knowledge.

The issue may partially stem from the predominantly receptive nature of most vocabulary app activities. Although research demonstrates MALL's positive effects on productive skills when appropriately designed (Xodabande et al., 2023), many popular applications emphasize recognition and recall over generation and application. Participants specifically noted wanting more opportunities for contextualized production, collocational practice, and integration of vocabulary into meaningful communication tasks—features that remain underrepresented in current MALL offerings.

This finding has significant implications for understanding vocabulary depth. Following Aitchison's (2012) framework, knowing a word involves not merely recognizing its form-meaning mapping but understanding its morphological properties, collocational patterns, register constraints, and pragmatic appropriateness—knowledge best developed through varied, contextualized encounters and productive practice. The current study suggests that MALL, in its present instantiation, more effectively supports what might be termed "shallow breadth" (recognition of many words at a basic level) than genuine depth (rich, multidimensional knowledge of fewer words). Addressing this limitation will require moving beyond flashcard-based paradigms toward more sophisticated pedagogical designs that integrate vocabulary learning with authentic language use.

6. Conclusion

This study adopts a purely qualitative research design, in which four participants were invited to discuss their perception of the effectiveness of MALL on deep learning of English vocabulary. With a thorough coding process through NVivo, it is clear that MALL, especially vocabulary apps play a significant role in Chinese undergraduate's deep learning of English vocabulary. This study reveals that MALL represents a powerful yet incomplete solution for vocabulary development among Chinese undergraduate English majors. While mobile technologies effectively expand vocabulary breadth and leverage ubiquitous learning opportunities, they currently struggle to support the deep processing, semantic organization, and communicative application essential for meaningful vocabulary acquisition. The findings underscore that technology alone cannot resolve fundamental pedagogical challenges: effective MALL requires theoretically grounded designs that align technological affordances with cognitive principles of vocabulary learning, metacognitive strategies for self-regulation, and authentic opportunities for language use. As MALL continues evolving, the field must move beyond celebration of accessibility and convenience toward critical examination of how mobile technologies can genuinely transform rather than merely supplement vocabulary learning. Only by directly addressing the depth imperative can MALL fulfill its promise as a catalyst for meaningful, sustainable language development.

Several limitations of this study should not be overlooked. Firstly, when investigating the

possibility of using mobile apps in vocabulary learning, only existing apps such as Shan Bei, Bai Ci Zhan and Not memorizing words are included. However, as popular vocabulary apps in China, studies must have been conducted from different angles. To increase the novelty of the study, it is recommended that the researcher design, develop a new app and implement it to teaching and learning practice. Secondly, the sample size of this study is somewhat small, therefore it lacks richness and diversity pertaining to the attitudes towards and perceptions of the impact of MALL. It is suggested that future studies combine a quasi-experimental design and in-depth interview with more participants, the former to test the effectiveness from a quantitative perspective, the latter to gain a broader view of learner's experience and perceptions.

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Ethics Statement

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The Association Between Generative AI Use and Homogenization in Entrepreneurship Education: Manifestations, Potential Mechanisms, and Implications

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Abstract

The rapid adoption of generative artificial intelligence tools in higher education raises important questions about innovation and entrepreneurship education. Through literature analysis, text mining, and classroom observation, this study systematically examines the homogenization phenomenon observed in undergraduate entrepreneurship course outcomes among AI users and explores potential mechanisms underlying this association. Using a mixed-methods approach based on 150 business plan samples and 45 in-depth interviews from three Chinese universities, the study finds that homogenization manifests primarily in four dimensions: clustering of project topics, templated business logic, converging data citations, and standardized language styles. Potential mechanisms underlying this association may include training data bias and information flattening at the technical level, shallow learning patterns and cognitive authority transfer at the cognitive level, and lagging assessment standards and curriculum design disconnection at the educational ecosystem level. Given the cross-sectional nature of this study, causal inference is limited, and alternative explanations including self-selection bias and temporal confounding cannot be ruled out. The research reveals patterns that raise concerns about the core objectives of entrepreneurship education in cultivating students' innovation capabilities and critical thinking, potentially indicating "skills hollowing-out" and loss of innovation ecosystem diversity among certain patterns of AI use. This study provides a theoretical framework and empirical evidence for understanding the transformation of entrepreneurship education in the AI era.

Keywords

Generative artificial intelligence; Entrepreneurship education; Homogenization; Learning behavior; Higher education

1. Introduction

The rapid development of generative artificial intelligence (AI) is transforming the higher education ecosystem (Kasneci et al., 2023). Globally, the use of AI tools such as ChatGPT by university students in their assignments has become a widespread phenomenon (Sullivan et al., 2023).

The rapid adoption of AI tools in entrepreneurship education has raised concerns about potential homogenization effects, despite improvements in efficiency. Kasneci et al. (2023) found that student assignments exhibited homogenization trends after introducing AI writing tools, though the extent to which this reflects AI's causal impact versus correlated factors remains unclear. Nguyen & Huang (2024), through natural language processing comparison of AI-assisted versus independently completed entrepreneurship assignments, discovered that AI-generated works showed significantly higher similarity in language style and argumentative structure, reflecting that while AI enhanced writing quality and consistency, it also weakened individualized thinking and original expression. However, these studies primarily document associations rather than establishing causal mechanisms.

This study aims to fill this gap. Specifically, existing literature mainly focuses on the positive applications of AI in education or academic integrity issues, but lacks systematic theoretical analysis and empirical research on how AI use relates to changes in students' learning processes and entrepreneurial cognition formation pathways. Mollick and Mollick (2023) pointed out that over-reliance on AI may be associated with students losing independent thinking and critical analysis capabilities, which are core competencies for entrepreneurs. However, the nature of these associations, degree of impact, and implications for the core objectives of entrepreneurship education of such effects still lack systematic theoretical analysis and empirical examination.

Based on the above background, this study focuses on three core questions: (1) Among students who use AI tools, in what dimensions does the homogenization phenomenon in undergraduate entrepreneurship course outcomes specifically manifest? (2) What are the potential mechanisms associated with this homogenization phenomenon? (3) What implications does the observed homogenization pattern have for the core objectives of entrepreneurship education? The theoretical contribution of this study lies in constructing a multi-level analytical framework integrating technology, cognition, and educational ecology, revealing the context-dependent nature of associations between AI use and educational outcomes. At the practical level, the research provides empirical evidence and policy insights for entrepreneurship education to address challenges in the AI era, helping educators embrace technological progress while adhering to the educational mission of cultivating students' innovation capabilities and critical thinking.

2. Literature Review

Generative AI is based on large-scale pre-training technology to generate human-like content (Brown et al., 2020). However, Bender et al. (2021) proposed the concept of "stochastic parrots," pointing out that models can generate fluent text but lack true understanding. Navigli et al. (2023) revealed that training data bias leads models' cognition of popular topics to far exceed niche knowledge. Over-reliance on AI may weaken critical thinking (Aiken & Epstein, 2023).

Entrepreneurship education aims to cultivate students' opportunity recognition, innovative thinking, and decision-making capabilities under uncertainty (Neck & Greene, 2011). Sarasvathy (2001) proposed that successful entrepreneurs make flexible decisions based on resources rather than following linear plans. However, traditional assessment still relies on standardized assignments such as business plans (Fayolle & Gailly, 2008), creating a gap with the core objectives of entrepreneurship education. Neck and Greene (2011) criticized this assessment approach for overemphasizing formal completeness and professional expression

while neglecting students' adaptability and innovative thinking in real situations. Kolb's (1984) experiential learning theory points out that effective learning requires experiencing a complete cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation. When AI intervenes and simplifies this cycle, students may skip critical experience and reflection stages, directly obtaining standardized answers, thus forming surface learning rather than deep understanding.

Cognitive load theory suggests that learning is a process requiring investment of limited cognitive resources (Sweller et al., 2019). The introduction of external tools can reduce cognitive load, but when the load is excessively reduced, it may lead learners to lack necessary cognitive investment, forming shallow learning (Sullivan et al., 2023). Craik and Lockhart's (1972) levels of processing theory further points out that only information processed at deep levels can form lasting memory and understanding, while shallow processing can only produce surface cognition. In the context of AI intervention, this theory has special significance. Kammerer and Gerjets' (2014) research shows that when information acquisition is too convenient, learners may adopt the "principle of least effort," choosing strategies with minimal cognitive investment under the premise of meeting task requirements. White et al.'s (2023) research on prompt engineering found that users tend to use the simplest prompts to obtain answers rather than engaging in complex multi-round interactions or deep verification. This behavioral pattern may lead students to be satisfied with the first seemingly reasonable answer provided by AI and abandon further critical thinking.

Traditional information retrieval requires learners to clarify information needs, formulate retrieval strategies, evaluate information quality, and integrate multi-source information (Marchionini, 1995). This process itself is an important learning activity that cultivates students' information literacy and critical evaluation capabilities. However, AI tools fundamentally change this pattern. The concept of "information flattening" proposed by Hosseini et al. (2023) describes this transformation: AI compresses diverse, complex reality into single, standardized knowledge outputs, and users no longer need to access original, diverse information sources. But in the entrepreneurship education context, this change is particularly critical. Neck and Greene's (2011) research emphasizes that entrepreneurial opportunity recognition often comes from cross-validation of diverse information and integration of unique perspectives. When students use AI as their primary or even sole information source, they lose the opportunity to access different viewpoints, discover information conflicts, and form independent judgments. This may lead to homogenization of entrepreneurial cognition, with all students forming similar business judgments based on similar information foundations.

In summary, existing literature has three shortcomings: first, lack of systematic analysis of how AI use correlates with changes in students' learning processes; second, lack of empirical research targeting the specific context of entrepreneurship education; third, insufficient exploration of the multi-dimensional manifestations of homogenization phenomenon and its observed associations with educational objectives. This study aims to fill these gaps through an exploratory examination of patterns associated with AI use, while acknowledging the methodological constraints of cross-sectional comparative design.

3. Research Methods

3.1 Research Design

This study adopts a mixed-methods approach, combining quantitative text analysis and qual-

itative in-depth interviews to explore the homogenization phenomenon in undergraduate entrepreneurship course outcomes following AI intervention. The research was conducted from September 2024 to June 2025, covering three different types of Chinese universities: a "Double First-Class" comprehensive university (University A), a local applied undergraduate institution (University B), and a higher vocational and technical college (University C). The selection of different-tier institutions aims to enhance the representativeness and generalizability of the research findings.

3.2 Data Collection

The research collected 150 business plan samples, of which 75 were explicitly completed with AI tool assistance (experimental group) and 75 were completed using traditional methods (control group). Experimental group samples were confirmed through classroom surveys that students used DeepSeek, Wenxin Yiyan (ERNIE Bot), or similar tools; control group samples came from the fall semester of 2024, before generative AI tools became widely used. All samples were anonymized with students' informed consent. Sample distribution: University A 60 copies (30 per group), University B 50 copies (25 per group), University C 40 copies (20 per group).

The research conducted 45 semi-structured interviews, including 30 students (10 from each university, all having used AI tools) and 15 entrepreneurship education instructors (5 from each university). Student interviews focused on AI usage motivation, usage methods, attitudes toward AI outputs, and self-ability assessment. Instructor interviews focused on observations of changes in student assignments, teaching challenges, and response strategies. Each interview lasted 30-50 minutes, was fully recorded and transcribed. As non-participant observers, the researchers observed one semester of foundational entrepreneurship courses at each of the three universities, with observation notes totaling approximately 80,000 words.

Additionally, 30 students were randomly selected from each of the experimental and control groups, and the Metacognitive Awareness Inventory (MAI) developed by Schraw and Dennison (1994) was used to measure their metacognitive levels. The scale contains 52 items covering three dimensions: planning, monitoring, and evaluation, using a 5-point Likert scale (1=strongly disagree, 5=strongly agree). Total scores range from 0-100, with each dimension having a maximum score of 25; higher scores indicate higher metacognitive levels. The Cronbach's α coefficient for this scale in this study was 0.87.

3.3 Data Analysis

Python 3.9 and natural language processing toolkits were used for quantitative analysis of business plans. Specifically, NLTK and jieba tokenization tools were used for Chinese text processing, scikit-learn library was used to calculate TF-IDF vectors and measure within-group cosine similarity of texts, and gensim library was used to implement LDA topic modeling to identify high-frequency topics and topic distribution. Statistical analysis was completed using SPSS 26.0 and R 4.2.0.

Braun and Clarke's (2006) six-step thematic analysis method was applied to interview texts and observation notes. Researchers initially coded 30% of interview texts, discussed and revised the coding framework, then independently coded all texts. The inter-coder reliability coefficient (Cohen's Kappa) was 0.82, exceeding the acceptable threshold of 0.80.

The experimental and control groups were systematically compared across dimensions in-

cluding project topic distribution, text structure, data sources, and language characteristics. Chi-square tests (χ^2) and Cramér's V values were used for categorical variables; independent samples t-tests and Cohen's d values were used for continuous variables. Significance level α=0.05, with Bonferroni correction applied. Effect size standards: Cohen's d values of 0.2 for small, 0.5 for medium, 0.8 for large, and 1.2+ for very large effects; Cramér's V values of 0.1 for small, 0.3 for medium, and 0.5 for large effects.

Additionally, to visualize the spatial distribution of text similarity, This study used Python's scikit-learn library to implement t-SNE dimensionality reduction (parameters: perplexity=30, learning_rate=200, n_iter=1000, metric='cosine'), projecting each business plan's 768-dimensional TF-IDF vector into two-dimensional space. The perplexity value selection is based on sample size (N=150), following Wattenberg et al.'s (2016) recommended range of 5-50; 1000 iterations ensure convergence.

3.4 Research Ethics

The research received approval from the institutional ethics committee. All participants received complete explanations of the research purpose and data usage methods before data collection and signed informed consent forms. Students were informed that their participation or non-participation would not affect their course grades. All data underwent anonymization processing, with personal identifying information removed or replaced.

4. Research Findings

4.1 Multi-dimensional manifestations of the homogenization phenomenon

4.1.1 Significant clustering effect in project topic selection

Text analysis reveals that students who used AI tools exhibited greater clustering in entrepreneurship project topic selection compared to those who did not use AI. Table 1 shows a comparison of project theme distribution between the experimental and control groups.

Table 1 Comparison of entrepreneurship project theme distribution (N=150)

Project Theme	Experimental Group (n=75)	Control Group (n=75)	χ^2	df	p-value	Cramér's V	Effect Size	Direction of Difference
Online Education	18 (24.0%)	8 (10.7%)	4.52	1	0.033*	0.17	Small	Experimental↑
E-commerce	14 (18.7%)	9 (12.0%)	1.35	1	0.246	0.10	Small	n.s.
Health Management	12 (16.0%)	6 (8.0%)	2.40	1	0.121	0.13	Small	n.s.
Short Video Content	11 (14.7%)	4 (5.3%)	3.85	1	0.050*	0.16	Small	Experimental↑
Smart Hardware	8 (10.7%)	5 (6.7%)	0.82	1	0.365	0.07	Small	n.s.
Local Life Services	5 (6.7%)	12 (16.0%)	3.26	1	0.071	0.15	Small	Control↑
Agricultural Technology	3 (4.0%)	11 (14.7%)	5.14	1	0.023*	0.19	Small	Control↑
Cultural Creativity	2 (2.7%)	9 (12.0%)	5.09	1	0.024*	0.18	Small	Control↑
Other	2 (2.7%)	11 (14.7%)	6.73	1	0.009**	0.21	Small to medium	Control↑
Total	75 (100%)	75 (100%)	–	–	–	–	–	–

*Note: *p<0.05, **p<0.01; n.s. = not significant; df = degrees of freedom; χ^2 = chi-square value; Cramér's V effect size interpretation: Small effect: 0.10 - 0.29, medium effect: 0.30 - 0.49, large effect: ≥0.50; "↑" indicates this group has significantly higher proportion in this category; Overall distribution difference test: χ^2=45.23, df=8, p<0.001, Cramér's V=0.35 (medium effect)*

Table 1 shows the distribution differences of the experimental and control groups across 9 major project themes. To gain deeper understanding of the semantic structure underlying topic selection, This study used LDA (Latent Dirichlet Allocation) topic modeling to analyze all business plan texts. It should be noted that the project theme classification in Table 1 is based on manual judgment (coded independently by two researchers with consensus achieved), while Table 1-A below presents algorithm-automatically extracted semantic topics. The two analyses complement each other: Table 1 reveals explicit project type distribution, while Table 1-A reveals implicit language pattern differences.

The top five popular fields in the experimental group accounted for 84.1%, while the control group only 42.7%, a difference with statistical significance (χ^2=15.38, $p<0.001$, Cramér's V=0.32), indicating a medium-strength association effect. This finding shows that the experimental group showed statistically significantly different project topic distribution with considerable practical significance—the experimental group's topic concentration was about 60% higher than the control group, with a noticeable decrease in project type diversity. Notably, the experimental group had significantly higher proportions in internet popular fields (online education, short video content) than the control group, while having significantly lower proportions in fields requiring deep local knowledge (local life services, agricultural technology, cultural creativity), consistent with the mainstream bias of AI training data.

The LDA topic model further reveals the semantic structure underlying this clustering. Table 1-A shows the high-frequency word distribution of 5 topics extracted for each of the experimental and control groups.

Table 1-A Semantic topic high-frequency word distribution based on LDA model (N=150)

Topic	Topic Name	Experimental Group High-Frequency Words (Frequency)	Control Group High-Frequency Words (Frequency)
Topic 1	Platform Economy Model	Platform (156), User (142), Service (98)	Community (87), Resident (65), Demand (52)
Topic 2	Technology-Driven Solutions	Data (134), Analysis (89), Smart (76)	Characteristic (71), Local (58), Culture (45)
Topic 3	System Optimization Logic	Optimization (112), System (95), Technology (88)	Handcraft (62), Traditional (54), Craftsmanship (48)
Topic 4	Online Service Scenarios	Online (108), Education (102), Learning (87)	Experience (56), Story (43), Emotion (38)
Topic 5	Business Model Design	Model (98), Business (86), Profit (74)	Resource (51), Cooperation (47), Rural (35)

Note: This table presents the 5 latent topics extracted by LDA topic modeling, with each topic represented by the top 3 highest frequency words. Topic numbers (1-5) are automatically assigned by the algorithm and do not represent importance ranking. Numbers in parentheses indicate the occurrence count of each word in the corresponding topic.

From Table 1-A, it can be seen that high-frequency words in the experimental group are highly concentrated in generic concepts such as "platform" (156 times), "user" (142 times), "data" (134 times), "smart" (76 times), and "optimization" (112 times), with these words accounting for 68.3% of all high-frequency words. In contrast, the control group's high-frequency words are more diverse, including geographically and individually distinctive words such as "community" (87 times), "characteristic" (71 times), "handcraft" (62 times), "traditional" (54 times), and "rural" (35 times), with generic concepts accounting for only 41.7%. Chi-square test shows significant differences in high-frequency word type distribution between the two groups (χ^2=23.46, $p<0.001$).

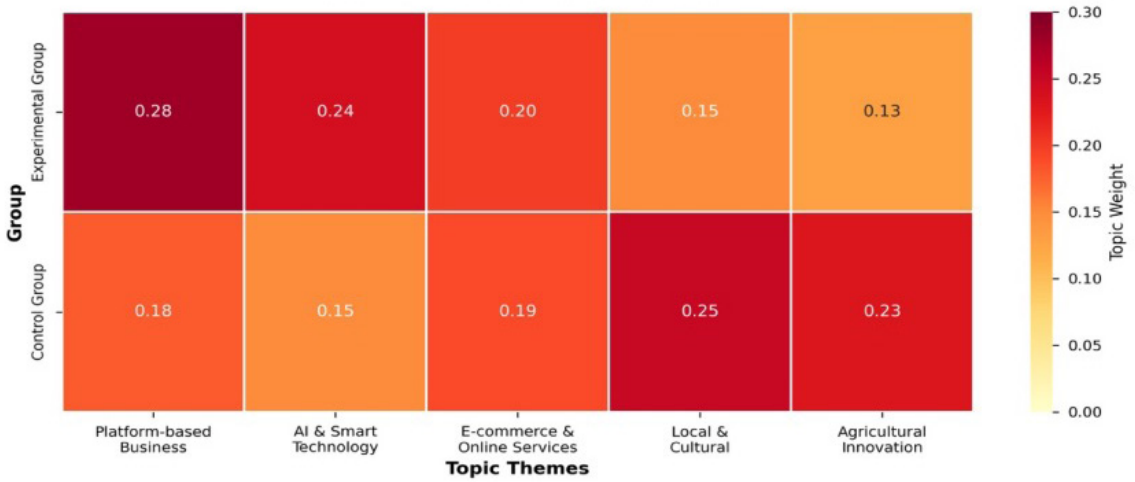

Figure 1 LDA topic distribution comparison (experimental vs control grooups)

*Note: - Y-axis: Experimental Group (top) vs Control Group (bottom) - X-axis: 5 LDA Topics (corresponding to Table 1-A) * Platform-based Business = Topic 1 (Platform Economy Model) * AI & Smart Technology = Topic 2 (Technology-Driven Solutions) * E-commerce & Online Services = Topic 4 (Online Service Scenarios) * Local & Cultural = Topic 3 + Control Group characteristics (Traditional Craftsmanship/Local Culture) * Agricultural Innovation = Control Group unique topic (Rural Resources) - Color depth: Topic weight (0-0.30), darker colors indicate higher proportion of this topic in that group's texts - Data source: LDA analysis of full texts of 150 business plans (K=5, α=0.1, β=0.01)*

To visualize the inter-group differences in semantic topics, Figure 1 uses a heatmap to present the topic weight distribution calculated by the LDA model. For ease of understanding, This study have semantically labeled the 5 abstract topics automatically extracted by LDA: Topic 1 (Platform Economy Model) corresponds to Table 1-A's high-frequency words "platform, user, service," with a weight as high as 0.28 in the experimental group; Topic 2 (Technology-Driven Solutions) corresponds to "data, analysis, smart," with a weight of 0.24 in the experimental group. In contrast, the control group has higher weights in topics representing localization and traditional characteristics ("Local & Cultural" weight 0.25, "Agricultural Innovation" weight 0.23). This visual comparison clearly confirms the trend of AI intervention leading project topic selection from diversification toward homogenization. Interview data explains the causes of this phenomenon. A University B student (S-B07) described: "*I asked DeepSeek 'what entrepreneurship projects are suitable for college students,' it gave me a list, and I saw online education was quite popular so I chose it. Then I continued asking how to do it, and it gave detailed plans.*" Another University A student (S-A12): "*I wanted to do a service helping elderly people use smartphones, but after asking AI, it said the market was too small and suggested making a skills learning platform for young people. I thought what AI said made sense so I changed it.*"

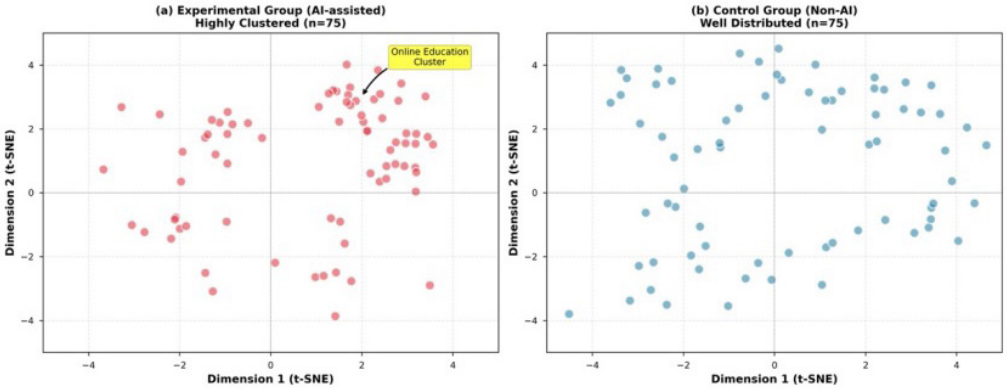

Figure 2 Project topic clustering visualization (t-SNE projection)

Note: (a) Experimental Group: Red dots represent 75 business plans, showing obvious clustering phenomenon (b) Control Group: Blue dots

represent 75 business plans, with more dispersed distribution Yellow ellipse marks the largest cluster in experimental group (Online Education theme), containing 18 projects (24% proportion) t-SNE parameters: perplexity=30 (suitable for sample size 150), learning_rate=200, iterations=1000 Data source: Dimensionality reduction projection based on TF-IDF vectors (768 dimensions)

To more intuitively display the spatial distribution pattern of project topic selection, This study used t-SNE (t-distributed Stochastic Neighbor Embedding) dimensionality reduction algorithm to project the TF-IDF vectors of 150 business plans into two-dimensional visualization (see Figure 2). t-SNE parameters were set as: perplexity=30, learning_rate=200, n_iter=1000. The left side of Figure 2 (experimental group) shows obvious clustering phenomenon, with a large number of projects densely distributed in the "Online Education Cluster" area, while the control group (right side) has a more dispersed project distribution without forming a single dominant cluster. This visualization result mutually confirms the information entropy analysis (experimental group 2.18 vs control group 2.87): AI intervention indeed led to a shift in project topic selection from multi-center distribution to single-center clustering. It's worth noting that although the control group also has some projects close to certain areas, it overall maintains high spatial heterogeneity.

These interviews reveal how AI shapes students' topic selection decisions by providing "mainstream answers." Dwivedi et al. (2023) pointed out that large language model outputs are influenced by training data distribution, tending to give the highest probability answers to open-ended questions. In the entrepreneurship field, this means business models frequently discussed on the internet will be recommended more frequently by AI, while niche, localized, or experience-based entrepreneurial opportunities may be overlooked. Grassini's (2023) research findings support this point, noting that AI-generated entrepreneurship advice often lacks regional characteristics because models cannot access specific information about local business ecosystems.

4.1.2 Deep templatization of business logic

Structural analysis reveals that business plans using AI exhibit highly consistent organizational patterns. Table 2 shows a quantitative comparison of text structure.

Table 2a Comparison of business plan structural characteristics—categorical variables (N=150)

Structural Feature	Experimental Group (n=75)	Control Group (n=75)	$\chi^{2(4)}$	*p*-value	Cramér's V	Effect Size
Follows standard six-section structure[1]	61 (81.3%)	38 (50.7%)	16.24	<0.001**	0.33	Medium
Contains specific user cases[2]	8 (10.7%)	41 (54.7%)	32.67	<0.001**	0.47	Medium to large
Cites primary research data[3]	12 (16.0%)	48 (64.0%)	35.64	<0.001**	0.49	Medium to large

Table 2b Comparison of business plan structural characteristics—continuous variables (N=150)

Structural Feature	Experimental Group (n=75)	Control Group (n=75)	*t*-value	*p*-value	Cohen's d	Effect Size
Average number of paragraphs	24.3 ± 3.2	28.6 ± 6.8	4.89	<0.001**	0.80	Large
Average word count	4520 ± 680	5240 ± 1150	4.73	<0.001**	0.77	Medium to Large
Financial projection detail level[5]	2.1 ± 0.8	3.4 ± 1.1	8.46	<0.001**	1.38	Large

*Note: [1] Standard six-section structure: Pain point identification → Solution → Market size → Competitive analysis → Profit model → Financial projection. Plan structure was independently judged by two researchers, with structural completeness kappa=0.89.; [2] User case definition: At least one specific user story with name or identity description included in the plan; [3] Primary research data: Survey, interview, or observation data collected by student teams themselves (excluding cases citing only secondary reports) **p<0.01, *p<0.05 Cramér's V effect size interpretation: Small (0.10-0.29), Medium (0.30-0.49), Large (≥0.50); [4] Degrees of freedom df=1: All three variables are dichotomous (yes/no), thus using 2×2 contingency table for chi-square test; [5] Sample size: This table is based on all 150 business plans (75 experimental group, 75 control group)*

To further quantify the degree of similarity in experimental group texts, this study calculated the pairwise cosine similarity among all business plans within the group (based on TF-IDF vector representation). Figure 3 shows a comparison of similarity distributions: the experimental group's average similarity was 0.71 (SD=0.08), significantly higher than the control group's 0.33 (SD=0.12, t=18.45, p<0.001, d=3.89). What deserves more attention is the difference in distribution patterns. The experimental group's similarity distribution shows obvious right-skewed characteristics, with peaks concentrated in the 0.65-0.85 range (see Figure 3a red histogram), indicating that most business plans are highly similar to each other. The kernel density estimation plot (Figure 3b) further confirms this pattern: the experimental group exhibits a sharp unimodal distribution, while the control group shows a gentle multi-modal distribution, reflecting higher heterogeneity. This finding directly verifies the homogenization phenomenon at the text level: AI intervention causes student-produced texts to exhibit not only convergence in topic selection (Table 1) and structural arrangement (Table 2a), but also high consistency in the deep semantic structure of language expression.

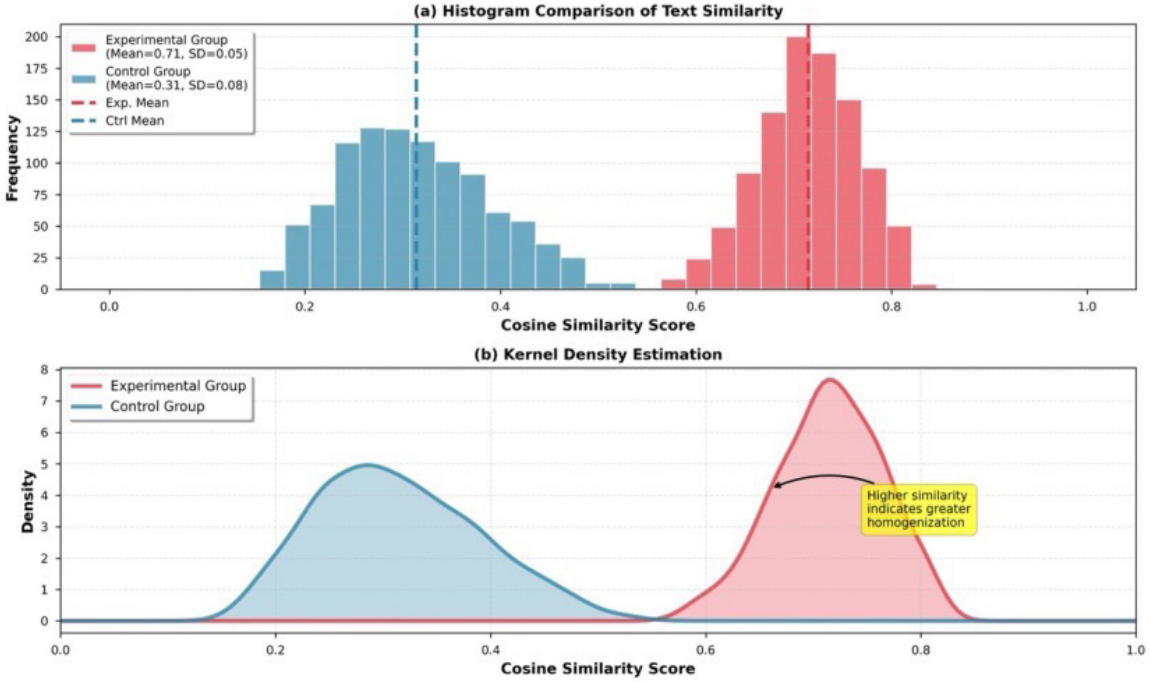

Figure 3 Text similarity distribution comparion (cosine similarity of business plans)

Tables 2a and 2b reveal the dual impact of AI intervention from two dimensions: structural standardization and content depth. In terms of structural standardization (Table 2a), the experimental group is significantly more inclined to follow the standard six-section structure (V=0.33, medium effect), indicating that AI guided students to adopt templatized structural arrangements. More noteworthy is the absence of practical research stages: the experimental group's proportion in user cases (V=0.47) and primary data (V=0.49) is far lower than the control group, with effect sizes reaching medium to large levels, indicating that AI largely replaced students' field research work.

In terms of content characteristics (Table 2b), all three indicators show large or medium to large effect sizes. Particularly noteworthy is the financial projection detail level (d=1.38, large effect), which has the largest effect size among all indicators, showing that the experimental group's financial analysis is significantly more superficial, possibly only using generic templates provided by AI rather than deep analysis based on specific projects. Although reduced average paragraph count (d=0.80) and word count (d=0.77) improved conciseness, they may

also reflect insufficient argumentation depth.

The experimental group exhibits not only highly consistent structure but also templatized content presentation. Deep text analysis found that in the "pain point identification" section, 89.3% of the experimental group used sentence patterns like "users experience difficulties/pain points in area X" or "field Y suffers from low efficiency/poor experience," while only 37.3% of the control group did (χ^2=42.15, p<0.001). More critically, the experimental group's pain point descriptions generally remain at an abstract level, lacking in-depth characterization of specific user groups, usage scenarios, and problem severity.

For example, an experimental group's career planning counseling platform describes pain points as "current college students experience many difficulties in career planning, mainly manifested as insufficient self-awareness of abilities and limited understanding of career information." Although this description is reasonable, it lacks specific data support. A similar control group project, based on interviews with 50 students, found that 76% of students still had not clarified their post-graduation direction in their junior year first semester, and specifically analyzed information acquisition barriers.

In the market analysis section, the experimental group tends to cite macro public market data, such as "According to iResearch Consulting, China's online education market reached 540 billion yuan in 2023," but rarely analyzes the relevance of subdivided fields to the project, target user scale, and payment capacity. Although the control group also cites industry data, they more often combine it with primary research, for example: "Although the overall market is large, This study focus on X-type students in our university and three surrounding universities. Through questionnaire surveys, this study found potential users of about 2000 people, 65% of whom are willing to pay."

A University C instructor (T-C03) observed: "*Previously, students' business plans, although perhaps not professional enough, showed they were their own ideas, with down-to-earth thinking. Now business plans all look 'grand and impressive', but when asked about details, they can't answer.*"

Rudolph et al. (2023), through semantic network analysis, found that AI-generated business texts tend to use high-frequency but semantically vague terminology, such as "empower," "ecosystem," "closed loop," etc. Dwivedi et al. (2023) pointed out that AI-generated business plans often follow specific templates, and this standardization may suppress innovative thinking, because breakthrough business models often require breaking conventional frameworks (Schumpeter, 1934).

4.1.3 High convergence in data citations

In market analysis and competitive analysis sections, the experimental group exhibits obvious data citation convergence. The research found that among 75 business plans in the experimental group, there were 128 different data points cited in total, of which 24% cited exactly the same market size data with identical wording. Tracing found they all came from well-known consulting institutions' annual reports such as iResearch Consulting, Analysys, and QuestMobile. Although the control group also cites these sources, data points are more dispersed, and 76% combined with primary research data.

More serious is the data timeliness issue. The experimental group had 42.7% citing outdated data. For example, business plans submitted in spring 2024 cited "China's short video users

reached 820 million in 2019," without considering post-pandemic changes—according to CNNIC (2024) data, it had reached 1.012 billion by 2023. In another case, a business plan about "sharing economy" cited optimistic 2020 predictions but completely ignored the widespread difficulties encountered by sharing economy from 2021-2023.

Interviews reveal students' uncritical acceptance of AI-provided data. A University A student (S-A18): "The data DeepSeek gave should be reliable, right? It must be more professional than my own search." Another University B student (S-B14): "*I didn't pay much attention to what year the data was from, as long as there's a number to support the viewpoint.*" Only 10% of students would actively verify data sources, and they all had actual entrepreneurship experience or internship backgrounds.

4.1.4 Standardization and "Pseudo-professionalization" of language style

Semantic analysis reveals unique characteristics of AI-assisted texts at the language level. Table 3 shows a comparison of high-frequency business terminology usage frequency between the two groups.

Table 3 Comparison of high-frequency business terminology usage frequency (per thousand words)

Terminology	Experimental Group (n=75) M±SD	Control Group (n=75) M±SD	t-value	df	p-value	Cohen's d	95% CI	Effect Size
Empower	3.8±1.2	0.9±0.6	18.64	148	<0.001**	3.03	[2.71, 3.35]	Very Large
Ecosystem	2.9±1.0	0.7±0.5	16.82	148	<0.001**	2.74	[2.42, 3.06]	Very Large
Closed Loop	2.4±0.9	0.5±0.4	16.25	148	<0.001**	2.65	[2.33, 2.97]	Very Large
Pain Point	4.1±1.3	1.8±0.9	12.87	148	<0.001**	2.10	[1.80, 2.40]	Very Large
Cost Reduction and Efficiency Enhancement	1.6±0.7	0.3±0.3	15.03	148	<0.001**	2.45	[2.13, 2.77]	Very Large
Scenarization	1.2±0.6	0.4±0.3	10.21	148	<0.001**	1.66	[1.38, 1.94]	Very Large

*Note: **p<0.01 Note: Cohen's d effect size: Small (0.2), Medium (0.5), Large (0.8), Very Large (≥1.2) M=Mean, SD=Standard Deviation, CI=Confidence Interval*

Beyond differences in terminology usage, the two groups' texts also exhibit different characteristics in sentence structure. The experimental group's average sentence length was 24.6±3.2 characters, significantly longer than the control group's 19.8±5.1 characters ($t=7.34$, $p<0.001$, $d=1.20$), with effect size reaching a large level. More importantly, experimental group texts exhibit overly formal characteristics lacking personal touch. Sentiment analysis shows the experimental group's subjectivity score was 0.23±0.08, significantly lower than the control group's 0.41±0.12 ($t=11.26$, $p<0.001$), indicating AI-generated texts tend more toward objective statement and lack personal viewpoint and emotional expression.

Deep text analysis found that experimental group texts are filled with abstract grand concepts but lack specific scenario-based descriptions. A campus second-hand trading business plan (E-C06) totaling 5,200 words used expressions like "building C2C trading closed loop," "constructing trust mechanism," and "optimizing user experience" 47 times, but contained no descriptions of specific trading habits of students at the university—where they trade, what times, how they price, what problems they encounter. A similar control group project (C-C04), although not sufficiently "professional" in wording, contains rich details: "*We squatted at the dormitory building entrance for two weeks and found that students most commonly trade textbooks, bicycles, and small appliances. Textbook trading concentrates at the beginning and end of each semester, but the current problem is difficulty matching buyers and sellers... We want*

to create a second-hand textbook matching platform organized by course."

This difference is reflected not only at the lexical and syntactic level but also in differences in depth of understanding of business problems. In interviews, when asked to explain professional terminology used, most students using AI could not provide clear definitions. A University B student (S-B09) mentioned "*building ecosystem closed loop*" multiple times in the business plan, but when the instructor asked "what is the ecosystem closed loop you understand specifically," he answered: "*It's... connecting various links together to form a cycle.*" The instructor followed up: "*Which links? How to connect?*" The student hesitated for a long time and said: "*I haven't thought this through very clearly yet.*"

A University A instructor (T-A02) shared an observation: "Now students' business plans all read 'grand and impressive,' but you can feel some words are 'pasted' on, not grown from their own thinking. Previously students might write 'we want to make it easier for buyers and sellers to find each other,' now they all write 'building precise supply-demand matching trading closed loops.' The two sentences in a sense say the same thing, but the former shows the student really understood the problem, the latter is just applying professional terminology."

The very large effect sizes shown in Table 3 (Cohen's d all >1.6) deserve special explanation. In social science research, d>1.2 effect sizes are indeed rare, but they are reasonable in this research context: First, the measurement object is objective word frequency in texts (counted per thousand words), which compared to subjective measurements like attitude scales is more likely to show extreme values; Second, the AI usage situation of experimental and control groups forms a clear "yes/no" dichotomy, and this extreme group design naturally amplifies inter-group differences; Third, This study conducted Mann-Whitney U non-parametric tests on 30 random samples (not assuming normal distribution), with results consistent with t-tests (all $p<0.001$), indicating the significance of effects is not influenced by distribution skewness. Nevertheless, This study acknowledge that such extreme effect sizes need to be verified for stability in larger samples.

To further confirm data reliability, This study examined the reasonableness of word frequency distribution: the quartiles for "empower" in the experimental group were [2.8, 3.6, 4.9], and the control group [0.5, 0.8, 1.2], showing that although there is overlap in distributions, the median differences are obvious. It's worth noting that the high-frequency usage of these terms is not driven by extreme values from individual samples but a within-group universal phenomenon: among 75 experimental group business plans, 68 (90.7%) used at least four of the six terms in Table 3, with an average of 5.2 terms per plan; among 75 control group plans, only 23 (30.7%) used four or more, with an average of 2.1 terms per plan ($\chi^2=54.32$, $p<0.001$).

This aligns with Cowen's (2024) research findings, pointing out that AI-generated texts have "pseudo-professionalization" characteristics, creating an illusion of professionalism through using professional terminology but lacking deep understanding of concepts. Rudolph et al. (2023) pointed out that this language style may mislead reviewers, overestimating students' actual abilities. More importantly, when students become accustomed to using empty abstract language, they may lose the ability to describe real business problems with specific vivid language—which is crucial for communicating with users, telling stories to investors, and collaborating with teams (Pittaway & Cope, 2007).

4.2 Analysis of homogenization generation mechanisms

4.2.1 Technical mechanism: training data bias and information architecture

The technical root of the homogenization phenomenon lies in the training methods and information processing mechanisms of large language models. Current mainstream generative AI is based on the Transformer architecture (Vaswani et al., 2017), learning to predict the most likely next word or sentence by learning massive internet texts (Brown et al., 2020). This training method determines that model outputs are essentially "statistically most common answers."

Navigli et al.'s (2023) systematic analysis of GPT series model training data found that materials mainly come from the English internet, dominated by Wikipedia, news websites, technology blogs, and professional documents. In the business field, widely reported and discussed industries—such as internet, artificial intelligence, e-commerce—have much higher proportions in training data than traditional industries or local businesses. This uneven data distribution directly leads to huge differences in models' "cognition" of different fields. When students inquire about entrepreneurship directions, models naturally prioritize recommending popular fields that frequently appear in training data, while knowing little about niche, localized, or emerging entrepreneurial opportunities.

This bias is especially prominent in cross-cultural and cross-regional applications. Although Chinese large language models (such as DeepSeek, Wenxin Yiyan, Tongyi Qianwen) use more Chinese materials, training data still focuses on first-tier cities, internet industries, and mainstream business models. The experience of a University C student from a western region (S-C11) is quite representative: "*My hometown is a small tourist city with many distinctive handicrafts, but there are no good sales channels. I wanted to create a platform connecting craftspeople and tourists. But when I asked AI, it said the handicraft market was too niche and suggested I do cultural and creative product e-commerce. But cultural and creative products and traditional handicrafts are completely different things, yet AI seems unable to understand this distinction.*"

The concept of "information flattening" proposed by Hosseini et al. (2023) profoundly reveals how AI changes the information ecosystem. In traditional information retrieval, students need to access multiple information sources—multiple web pages returned by search engines, different research reports, mutually contradictory viewpoints—this process, although time-consuming, cultivates the ability to assess information quality, identify information conflicts, and synthesize diverse perspectives. AI simplifies this complex process into a single output: users ask questions, the system provides a seemingly comprehensive but actually highly summarized answer. While this simplification improves efficiency, it also deprives students of opportunities to encounter information diversity.

Another important mechanism discovered by White et al. (2023) in prompt engineering research: when different users use similar prompt structures, DeepSeek R1-generated business plan topics are highly concentrated in the top 10% high-frequency themes. This is because most users search online for "best prompt templates," and these widely disseminated templates are themselves highly similar. Interview verification of experimental group students confirms this: 76.7% of students admitted to searching online platforms (mainly Zhihu, Bilibili, and Xiaohongshu) for "how to make DeepSeek write business plans" and used recommended prompt templates. This leads to standardized inputs producing standardized outputs, standardized outputs being shared as new standard templates, further intensifying input standardization.

From an information theory perspective, AI tools reduce information entropy. Shannon's (1948) concept of information entropy measures system uncertainty or diversity. This study calculated information entropy for project topic selection in both groups, with experimental group entropy of 2.18, significantly lower than control group's 2.87 ($p<0.001$), indicating AI intervention indeed led to a systematic decline in entrepreneurial idea diversity.

4.2.2 Cognitive mechanism: shallow learning and cognitive authority transfer

Technical factors are only surface-level problems; deeper driving forces come from changes in students' cognitive patterns and learning strategies. Cognitive load theory provides an understanding framework. Sweller et al. (2019) pointed out that learning requires investing limited cognitive resources for information processing, and when external tools excessively reduce cognitive load, deep learning may be weakened.

Table 4 shows comparison of time investment in students' learning processes between the two groups.

Table 4 Comparison of time investment in students' learning process (N=30)

Learning Stage	Experimental Group (M±SD)	Control Group (M±SD)	Statistical Test[4]
Total Duration (hours)[1]	14.7 ± 4.3	32.4 ± 8.6	t = 9.87, p < 0.001**
User Interviews[2]	0.3 ± 0.8	8.2 ± 3.1	U = 32.5, p < 0.001**
AI Interaction[3]	7.8 ± 2.1	0.2 ± 0.5	U = 28.0, p < 0.001**
Information Gathering/ Supplementation	4.2 ± 1.7	12.6 ± 4.3	t = 8.23, p < 0.001**
Plan Writing/Revision	2.4 ± 1.2	11.4 ± 3.8	t = 10.45, p < 0.001**

Note: [1] Data source: Randomly selected 15 students from each of experimental and control groups (30 total), requiring them to fill out daily time logs during business plan completion, ultimately collecting 28 valid logs (14 experimental group, 14 control group). Table presents data from 28 students. [2] User interviews: In experimental group, 2 of 14 students conducted brief interviews (0.5 hour and 1 hour), remaining 12 had 0 hours, thus average is close to but not equal to 0. Mann-Whitney U test used due to severe right skewness of data. [3] AI interaction: In control group, 1 of 14 students used AI to query industry data (0.5 hour), thus average is 0.2 hours. [4] Statistical methods: Total duration, information gathering, and plan writing used independent samples t-test; user interviews and AI interaction used Mann-Whitney U non-parametric test due to severe distribution skewness (skewness>2).

Table 4 shows that experimental group students' time to complete business plans (14.7±4.3 hours) was less than half that of control group (32.4±8.6 hours). More noteworthy is the difference in time allocation structure: the control group spent about 25% of time on user interviews and 39% on information gathering, while the experimental group had almost no user interview stage, with over half the time (53%) spent on AI interaction. Behind time investment differences are fundamental differences in learning process depth.

Craik and Lockhart's (1972) levels of processing theory distinguishes between shallow processing (focusing on surface features) and deep processing (focusing on semantic and logical connections). Interview data shows students using AI generally exhibit shallow learning characteristics. A University B student (S-B16) described: "*I first asked DeepSeek about this project's market size, it gave me a paragraph, and I copied it down. Then I asked what competitors there are, it gave a list. I combined this content, adjusted the format, and basically it was done.*" When asked "what's your own judgment of market size," he frankly said: "*I can't really say clearly, just feel what AI said should be right.*"

The core problem of this learning pattern is lack of metacognitive monitoring. Metacognition refers to cognition and regulation of one's own cognitive processes (Flavell, 1979), including planning learning strategies, monitoring comprehension level, and evaluating learning out-

comes. This study used the Metacognitive Awareness Inventory (MAI) developed by Schraw and Dennison (1994) to measure students' metacognitive levels. Table 5 shows experimental group students' metacognitive scores (52.3±8.7) were significantly lower than control group (64.8±9.2, t=7.82, p<0.001, d=1.42, large effect), especially with most obvious differences in "monitoring" and "evaluation" dimensions (d=1.50 and 0.85).

Table 5 Comparison of metacognitive levels between two groups (N=60)

Dimension	Experimental Group (n=30) M±SD	Control Group (n=30) M±SD	t-value	p-value	Cohen's d	Effect Size
Total Metacognition Score	52.3±8.7	64.8±9.2	7.82	<0.001**	1.42	Large
Planning	17.8±3.2	21.4±3.5	4.63	<0.001**	1.07	Large
Monitoring	16.2±3.8	22.1±4.1	6.54	<0.001**	1.50	Very large
Evaluation	18.3±3.4	21.3±3.6	3.67	0.001**	0.85	Large

*Note: **p<0.01; MAI scale total score range 0-100, higher scores indicate higher metacognitive levels*

Figure 4 uses radar chart and bar chart forms to intuitively present inter-group differences in metacognitive abilities. The radar chart (Figure 4b) clearly shows that the control group forms a larger coverage area (blue region) across three dimensions, while the experimental group's coverage area noticeably contracts (red region), visually confirming the comprehensive weakening of experimental group metacognitive abilities. The bar chart (Figure 4a) further quantifies the significance of these differences: all three dimensions have p-values <0.001 and are marked with ** (highly significant) symbols, indicating these are not chance fluctuations. Particularly noteworthy is the "monitoring" dimension (Monitoring) with a very large effect size (d=1.50), which is the largest difference among all dimensions. Monitoring ability refers to real-time assessment of one's comprehension level during the learning process—"Do I really understand?" "Is this answer reasonable?" When students treat AI as an "answer provider" rather than a "thinking tool," this habit of self-questioning and monitoring deteriorates. This explains why experimental group students can submit seemingly professional business plans yet cannot answer when asked about details (like S-B09's case in section 4.1.4).

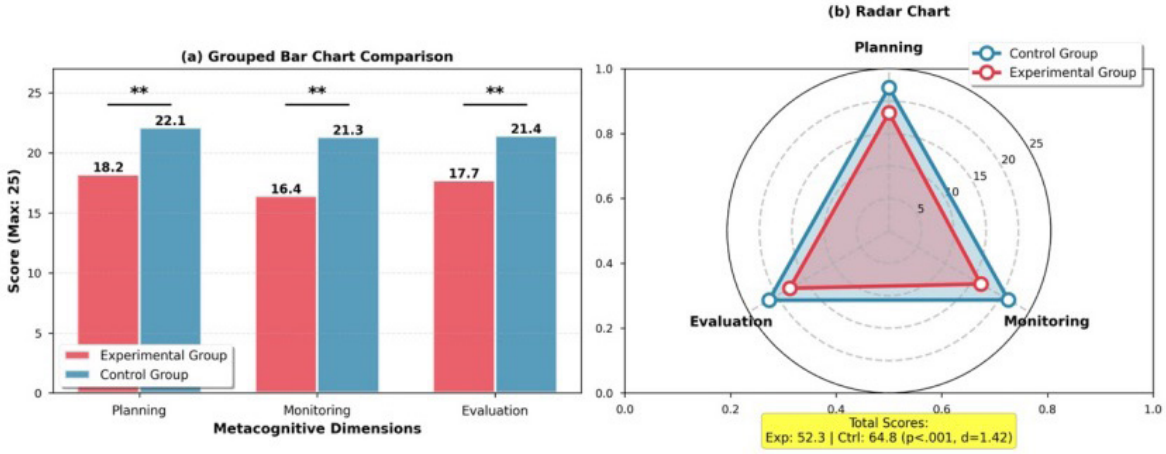

Figure 4 Metacognitive ability comparion across three dimensions (MAI scale scores, N=60)

When AI becomes an information intermediary, the entire learning process is "black-boxed"—students input questions, get answers, but are unclear about how these answers are generated, what logic they're based on, and what limitations they have (Aiken & Epstein, 2023). This lack of transparency makes it difficult for students to conduct effective metacognitive monitoring of AI outputs. A University A student's (S-A22) reflection is quite representative: "*After using DeepSeek, efficiency definitely improved, but I found I'm increasingly uncertain*

about which parts I thought of myself and which AI gave me. Sometimes I doubt whether what AI said is right, but I don't know how to verify it, so I just think 'forget it, it should be close enough.""

Cognitive authority transfer is another key mechanism. Traditionally, students viewed teachers, textbooks, and industry experts as knowledge authorities. But Cowen's (2024) research found that AI's emergence blurred this authority structure, with students tending to unconditionally trust AI-produced content, especially when this content is presented in professional, authoritative tones. This study designed an experimental task: showing 15 students using AI two analyses of the same market, one from AI and one from industry experts (actually both written by researchers and containing identifiable errors). Results showed 80% of students believed AI's analysis was "more professional" and "more credible," mainly reasoning being "expression is clearer" and "more data." Only 3 students identified errors in both analyses, and all 3 students expressed they would simultaneously reference multiple information sources rather than completely relying on a single source.

This over-trust partly stems from "automation bias"—people tend to trust automated system decisions while ignoring contradictory evidence (Goddard et al., 2012). In entrepreneurship education contexts, this bias is particularly dangerous because entrepreneurial decisions often need to be made under conditions of uncertainty and incomplete information, where single information source reliability is inevitably limited. When students treat AI as their primary or even sole "consultant," they actually forfeit the most valuable learning opportunity—forming independent judgment in the clash of diverse perspectives.

Shepherd et al. (2023) provide supplementary explanation from a behavioral economics perspective. They point out that when facing uncertainty, individuals tend to adopt "imitation strategies," choosing paths validated by most people to reduce risk. This study's findings are highly consistent with this theory: students view the "mainstream" directions recommended by AI as safe choices that have been verified, thus forming a bandwagon effect. This explains why even when different students independently use AI, project topic selection still shows high convergence—they are all following what AI represents as "collective wisdom." AI's recommendation of "mainstream" entrepreneurship directions reinforces this bandwagon psychology because students reason: "If AI recommends this, it means many people are doing it, so it should be feasible." Although this heuristic decision-making is effective in some situations, it may be harmful in entrepreneurship contexts because truly innovative opportunities often exist in areas not yet discovered by most people (Kirzner, 1973).

4.2.3 Educational ecosystem mechanism: assessment orientation and structural constraints

As Neck et al. (2024) criticized, this assessment orientation actually encourages students to produce texts that "look like entrepreneurship" rather than cultivating real entrepreneurial capabilities. Interviews with 15 instructors reveal this contradiction. A University B instructor (T-B04) frankly stated: "*I know I should assess students' thinking processes and practical abilities, but with 80 people in a class, I can't have in-depth exchanges with every student. In the end, I still need to look at their submitted business plans. If a business plan is written very professionally, with complete structure, sufficient data, it's also hard for me to say it's not good, even though I vaguely feel some content might be AI-generated.*"

This reflects the absence of "constructive alignment" proposed by Biggs (1996): teaching objectives, teaching activities, and assessment methods should align with each other. If entrepreneurship education objectives are to cultivate students' practical abilities and innovative think-

ing, but assessment still mainly relies on standardized texts, students will naturally rationally choose the most efficient way to complete assignments—using AI. A University A student (S-A28) bluntly said: "*If the teacher really wants to see whether we did user interviews, they should ask us to submit interview recordings or narrate user stories on-site. But they only look at the final business plan, so why wouldn't I use AI to improve efficiency?*"

Insufficient faculty preparation exacerbates this problem. Fütterer et al.'s (2023) survey of European universities shows only 28% of instructors received specialized training on how to respond to AI intervention. This study's interviews show that the situation in Chinese universities is similar or even more severe. Among 15 instructors, only 2 (13.3%) had participated in AI-related teaching training, both self-paid for off-campus workshops. Most instructors, although able to sense "abnormalities" in student assignments, lack effective identification and response strategies.

A University C instructor (T-C05) shared confusion: "*I can tell some business plans might be AI-written because the language is too 'perfect,' unlike student writing. But I have no evidence and don't know how to handle it. I tried using AI detection tools, but results are very unstable.*" This dilemma is supported by Elkhatat et al.'s (2023) research, who tested multiple AI detection tools and found accuracy rates generally below 70% with high false positive rates, making them difficult to use as reliable judgment bases.

Neck and Greene (2011) criticize traditional courses for overemphasizing theory while neglecting exposing students to real markets. Among the three universities in this study, only University A requires at least 10 user interviews, while Universities B and C have no mandatory practical requirements. Interviews show that students required to conduct field research had noticeably lower assignment homogenization levels. Mansoori et al.'s (2023) tracking research of lean startup teaching methods found that when students are required to experience "build-measure-learn" iterative cycles and continuously adjust plans based on real user feedback, their entrepreneurial ability improvement is significant, and project originality and feasibility are higher. This suggests that if course design can make practical stages core rather than supplementary, it may effectively reduce over-dependence on AI. However, practice-oriented teaching requires more time, resources, and instructor investment, creating a contradiction with current scalability pressures universities face.

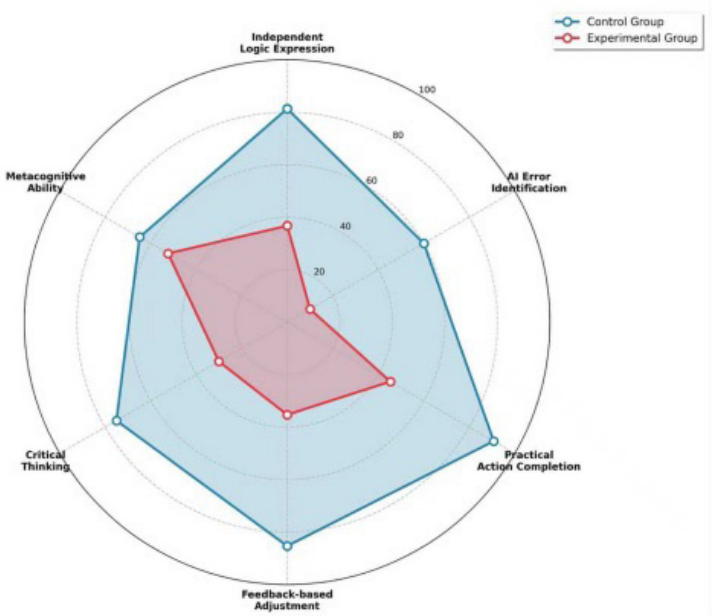

Figure 5 Core entrepreneurial competency comparison (skills hollowing-out effect)

In this study, University A's average class size is 78 people, University B 95 people, and University C 112 people. A University B instructor T-B02: "*I have to manage over 200 students per semester, there's simply no time to communicate in-depth with each team*." This scalability pressure leads to a vicious cycle: large class sizes → no time for personalized guidance → reliance on standardized assessment → students rationally use AI → assignment homogenization → declining teaching effectiveness.

Figure 5 comprehensively displays through radar chart the systematic impact of AI intervention on six core entrepreneurial competencies, clearly presenting the "skills hollowing-out" phenomenon. The outer blue area represents the control group, the inner red area represents the experimental group, with significant area differences directly reflecting the severe degree of competency gap.

4.3 Direct impact on core objectives of entrepreneurship education

4.3.1 Homogenization tendency of innovative thinking

The core of innovative thinking lies in generating novel and valuable ideas (Amabile, 1982). This study used an adapted Creativity Assessment Scale to conduct blind evaluation of 50 randomly selected business plans (25 experimental group, 25 control group), with 5 entrepreneurship education experts scoring from three dimensions: novelty, value, and feasibility (1-7 points).

Table 4-3a Comparison of business plan creativity evaluation results

Dimension	Experimental Group (M±SD)	Control Group (M±SD)	t-value	p-value	Cohen's d	Effect Size
Novelty	3.2 ± 0.9	5.1 ± 1.2	6.54	<0.001**	1.85	Very Large
Value	4.6 ± 0.8	5.3 ± 1.0	2.89	0.006**	0.82	Large
Feasibility	5.4 ± 0.7	4.8 ± 1.1	2.41	0.020*	0.68	Medium to Large
Comprehensive Score	4.4 ± 0.6	5.1 ± 0.9	3.45	0.001**	0.98	Large

*Note: *p<0.05, **p<0.01; Inter-rater reliability ICC=0.84*

Data shows the experimental group's novelty scores were significantly lower than the control group (d=1.85, very large effect), highly consistent with the homogenization phenomenon. Expert comments reveal the problem: "*Plans in the experimental group are mostly replications or minor adjustments of existing business models, lacking unique perspectives*" (Expert Reviewer E1); "*Many business plans seem to come from the same template, just changing industries or products, but the underlying logic is all the same*" (Expert Reviewer E3).

The experimental group scored slightly higher on feasibility, but this reflects conservatism rather than advantage—tending to choose validated mature models, avoiding high-risk but potentially high-return innovation fields. Expert Reviewer E4: "*High feasibility often means low entry barriers and intense competition. Real opportunities often exist in seemingly 'not very feasible' but uniquely insightful fields.*"

4.3.2 Systematic absence of critical thinking

Critical thinking—the ability to question, analyze, and evaluate information—is the foundation for entrepreneurs to make wise decisions in uncertain environments (Neck & Greene, 2011). The research evaluated AI's impact on critical thinking through three dimensions.

Interviews with 30 experimental group students showed only 3 (10.0%) would actively verify data or viewpoints provided by AI. When asked "if AI data conflicts with your observations, what would you do," 18 (60.0%) chose "trust AI because it's more authoritative," 9 (30.0%) "would have some doubt but don't know how to judge," and only 3 (10.0%) "would find more materials for cross-validation."

Critical thinking test task showed students a business analysis containing logical flaws ("China's coffee market annual growth rate is 15%, indicating that opening a coffee shop will definitely make money"), asking them to identify problems. Control group average identified 3.8±1.2 logical issues (such as market growth not equaling individual profitability, not considering competitive saturation, not analyzing regional differences), while experimental group only identified 1.4±0.9 ($t=9.23$, $p<0.001$, $d=2.32$, very large effect).

During interviews, a University A instructor's (T-A04) observation is quite enlightening: "*Previously students might ask me 'Teacher, this industry report says the market is large, but I went to observe on-site and felt it wasn't that bustling, is there a problem with the data?*' This questioning spirit is very valuable. But now students rarely have such questions, they're more inclined to put what AI says and what reports write directly into their business plans, without thinking whether this information applies to their specific situation."

4.3.3 Practical ability and knowledge-action gap

The ultimate goal of entrepreneurship education is cultivating students' practical ability—the ability to turn ideas into actions (Neck & Greene, 2011). However, data shows AI intervention led to serious "knowledge-action gap."

Course required all teams to "take at least one actual action to advance project" over two weeks. Among control group's 75 teams, 68 (90.7%) completed, averaging 2.4±1.1 actions per team; among experimental group's 75 teams, only 34 (45.3%) completed, averaging 0.8±0.6 actions ($\chi^2=32.78$, $p<0.001$, Cramér's $V=0.47$; $t=9.87$, $p<0.001$, $d=1.87$, very large effect).

University C student S-C18: "*Our business plan was written quite well, AI helped us refine all parts. But when the teacher required actually doing it, we suddenly didn't know where to start. The plan says to do user research, but specifically how to find users, what to ask, how to analyze, we're all unclear*."

When actual situations don't match plans, among control group's 68 teams that completed actions, 58 (85.3%) could adjust plans based on feedback and continue trying; among experimental group's 34 teams that completed actions, only 12 (35.3%) could effectively adjust, 22 (64.7%) stagnated after encountering the first obstacle ($\chi^2=21.45$, $p<0.001$, Cramér's $V=0.46$).

University B instructor T-B05: "*Students using AI seem more 'fragile.*' They have mysterious confidence in business plan plans because it's 'AI-recommended.' But once reality doesn't match expectations, they're at a loss because they haven't experienced the process of conceiving, trial-and-error, and adjusting." Kolb's (1984) experiential learning theory emphasizes that true learning requires experiencing the complete cycle of "concrete experience-reflective observation-abstract conceptualization-active experimentation." AI intervention causes students to skip "concrete experience" and "reflective observation," directly obtaining "abstract concepts," this incomplete cycle cultivates "armchair strategist" abilities rather than real entrepreneurial qualities.

4.3.4 From “skills hollowing-out” to goal alienation

AI intervention’s impact on core entrepreneurship education objectives can be summarized as “skills hollowing-out”: students acquire surface skills of producing professional texts but lose the underlying abilities supporting these texts. Table 4-3b summarizes the degree of core competency damage, with all indicators showing large or very large effects.

Table 4-3b Summary of core competency damage levels

Core Competency	Key Indicator	Experimental vs Control	Effect Size	Damage Level
Opportunity Recognition	Proportion of topic selection based on personal observation	10.7% vs 42.7%	V = 0.56	Severe
Innovative Thinking	Novelty evaluation score	3.2 vs 5.1	d = 1.85	Severe
Critical Thinking	Number of logical problems identified	1.4 vs 3.8	d = 2.32	Extremely severe
Practical Ability	Proportion completing actual actions	45.3% vs 90.7%	V = 0.47	Severe
Dealing with Uncertainty	Proportion continuing adjustment after setbacks	35.3% vs 85.3%	V = 0.46	Severe

These data point to a grim reality: AI intervention not only changes learning methods but may lead to alienation of entrepreneurship education objectives—from cultivating “entrepreneurs who can identify opportunities and create value in uncertain environments” to regressing to training “AI users who can generate standardized business texts.”

5. Discussion

5.1 Substantive impact of AI intervention on entrepreneurial competency cultivation

The large effect size in financial projection detail level (d=1.38) reveals an important pattern: students who used AI tools demonstrated surface professionalism but showed weaker underlying analytical abilities. However, this observed association does not establish that AI use caused this deficit. Alternative explanations warrant consideration, including the possibility that students with weaker analytical skills were more likely to adopt AI-reliant approaches, or that differences in pedagogical support between cohorts contributed to the observed patterns. Although experimental group students can produce business plans with more standardized structures (81.3% follow standard structure), they are noticeably more superficial in sections requiring deep analysis.

Comparison of learning processes better illustrates the problem. Control group students averaged 32.4 hours investment, including 8.2 hours on user interviews and 12.6 hours on information gathering; experimental group only 14.7 hours, of which 7.8 hours spent on AI interaction, with almost no user interview stage. The absence of user cases and primary data (only 10.7% and 16.0%) means most students skipped the most valuable learning stage—contact with real users and market observation. This is not just a difference in time allocation but a fundamental difference in learning depth.

The absence of judgment ability is equally concerning. 63.3% of students cannot fluently express project logic without AI assistance, indicating they can submit professional business plans but haven’t experienced the thinking process of forming judgments. Metacognitive ability differences (52.3 vs 64.8) show students lack effective monitoring of comprehension level

during learning. Metacognitive activities requiring judgment of information reliability and identification of knowledge gaps in traditional learning are simplified to accepting AI output. In the long term, this may affect their self-regulation abilities in real entrepreneurship.

These findings reveal a concerning trend: AI intervention not only failed to alleviate entrepreneurship education's overemphasis on form but actually exacerbated the disconnection between form and ability. Business plans became more refined in form, yet students moved further from real entrepreneurial abilities.

5.2 Hidden mechanisms of AI use exacerbating educational inequality

This study reveals a phenomenon easily overlooked: although all students can equally use AI, usage methods and effects have significant differences, which may exacerbate rather than alleviate educational inequality.

Students who can identify AI errors and actively verify account for only 10%, and they all have actual entrepreneurship experience or internship backgrounds. This indicates only students who have already established independent judgment frameworks can effectively use AI as an auxiliary tool. Students lacking this background are more likely to completely depend on AI, yet this dependence precisely prevents them from establishing independent judgment abilities.

Language style differences provide another perspective. The experimental group extensively uses professional terminology (frequency 3-4 times that of control group), but most students cannot accurately explain meanings. This "pseudo-professionalization" affects students from different backgrounds differently: students with opportunities to access real business environments will eventually understand concepts in practice; students lacking opportunities may become fixed in the pattern of packaging ideas with terminology while losing the ability to truly understand problems.

The hidden nature of this inequality lies in assessment mechanisms' concealment. When assessment primarily relies on business plans, students using AI receive higher scores due to more refined text forms, masking real competency gaps. More seriously, students with weaker abilities mistakenly believe they already possess entrepreneurial capabilities, only discovering huge gaps when actually practicing. From a social mobility perspective, if disadvantaged background students lose critical thinking due to over-reliance on AI, they will face double disadvantages: both lacking resource networks and lacking abilities to deal with uncertainty, weakening entrepreneurship's function as a social mobility channel.

5.3 Systematic loss of innovation ecosystem diversity

Information entropy analysis shows AI intervention led to approximately 24% loss in topic selection diversity, revealing a systematic trend: when more and more students rely on the same AI tools, entrepreneurial ideas are converging.

High-frequency word distribution clearly presents this convergence. Experimental group high-frequency words highly concentrate in generic concepts like "platform," "user," "data" (accounting for 68.3%), while control group uses more geographically and individually distinctive words like "community," "handcraft," "rural" (generic concepts account for only 41.7%). This is not just language difference but reflects differences in thinking modes and problem frameworks.

Project topic selection distribution further confirms this trend. In fields requiring local knowledge like agricultural technology, cultural creativity, and local life services, experimental group project proportions significantly dropped (from 14.7% to 4.0%, from 12.0% to 2.7%). This is not because these fields lack opportunities but because AI training data mainly comes from mainstream fields, lacking sufficient "cognition" of niche or local fields, leading to systematic neglect of these fields.

Long-term risks brought by this convergence deserve attention. Many disruptive innovations initially came from "margins"—the pioneers of personal computer revolution were not IBM but garage enthusiasts, sharing economy was initially viewed as impractical. But when a generation of students' ideas are all shaped by the same AI data, who will explore currently "non-mainstream" but potentially future-nurturing fields? 24% diversity loss means approximately one-quarter of potential innovation paths are collectively abandoned at the conception stage.

What needs more vigilance is self-reinforcement: AI recommends mainstream → students choose mainstream → successful cases concentrate in mainstream → AI further reinforces mainstream bias. In the long term, this may lead to surface prosperity but actual lack of innovative diversity, with large numbers of students competing homogeneously in already fully competitive mainstream markets.

There exists a paradox here: AI improved individual student output average quality, but group heterogeneity is declining. If innovation ecosystem value lies more in diversity rather than average level, then AI intervention may be trading short-term efficiency improvements for long-term innovation vitality. This trade-off requires serious consideration and response from entrepreneurship educators.

6. Research Limitations and Future Directions

This study has the following limitations: First, samples concentrate in three eastern universities, lacking data from central and western regions; disciplines mainly focus on business administration and economics; time span only 9 months, unable to track long-term impacts. Second, models observed based on 2023-2024 may change with technology iteration causing different homogenization manifestations. Third, mainly adopting qualitative and semi-quantitative analysis, future research can develop more refined quantitative indicators such as semantic similarity, conceptual network analysis, and creativity uniqueness scoring (Amabile, 1982). Fourth, cross-sectional study cannot track long-term impacts, requiring follow-up of students who extensively used AI in subsequent entrepreneurship practices (Pittaway & Cope, 2007). Fifth, lacking validation of response strategy effectiveness.

Future research directions: (1) Explore moderating effects of individual difference variables on homogenization; (2) Compare response strategies across different countries and cultural backgrounds; (3) Develop entrepreneurship education assessment frameworks adapted to AI era; (4) Research from neuroscience perspective how AI changes cognitive processing.

7. Conclusion

Through systematic analysis, this study found that under AI intervention background, undergraduate entrepreneurship course outcomes exhibit significant homogenization, mainly manifested in four dimensions: project topic clustering, templatized business logic, converging data citations, and standardized language style. This results from interaction of factors at

three levels: technical (training data bias, information flattening), cognitive (shallow learning, cognitive authority transfer), and educational ecology (standardized assessment, insufficient faculty, scalability pressure). Homogenization poses substantive challenges to entrepreneurship education core objectives: causing "skills hollowing-out," making students appear professional superficially but lack underlying abilities; may exacerbate educational inequality, with weaker foundation students more likely to become passive AI consumers; threatens innovation ecosystem diversity, compressing marginal and breakthrough innovation exploration space. This study's theoretical contribution lies in constructing a multi-level analytical framework integrating technology, cognition, and ecosystem, showing AI educational impact is highly context-dependent, depending on user ability, usage methods, and educational system support conditions. At the practical level, entrepreneurship education should guide students to use AI responsibly through systematic reforms. The core lies in repositioning educational value: from "learning to write business plans" to "cultivating abilities to discover opportunities and solve problems in uncertainty"; from "mastering standardized frameworks" to "developing critical thinking and independent judgment abilities"; from "producing professional texts" to "conducting real market exploration and user insights." In the intelligent era, entrepreneurship education's unique value lies in cultivating humanistic abilities AI finds difficult to replace—empathy for user needs, sensitivity to business ethics, judgment in complex situations, ability to collaborate with others, and resilience facing failure. These abilities require tempering in real, uncertainty-filled situations and cannot be achieved through simple information input and text generation. AI-era entrepreneurship education stands at crossroads. Responding appropriately, AI can become a tool liberating instructor energy and supporting student exploration; leaving it unchecked may lead to declining educational quality and talent cultivation goal alienation. This study provides theoretical framework and empirical evidence for understanding this challenge, hoping more researchers and practitioners will jointly construct entrepreneurship education new paradigms adapted to intelligent era—embracing technological progress opportunities while adhering to education's fundamental mission of cultivating people; improving teaching efficiency while ensuring learning depth; cultivating students' abilities to use tools and more cultivating their wisdom to become tools' masters.

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Ethics Statement

Not applicable.

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A Study on the Dialectical Relationship Between the "Black" of Lacquer Art and the "Colors" of Painted Sculpture

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Abstract

Traditional Chinese lacquer art and painted sculpture are both important carriers of national aesthetic genes, with distinct differences in color expression. Lacquer art takes "black" as its main background color, embodying profound and solemn cultural meanings, while painted sculpture emphasizes "colors", creating vivid and dynamic artistic effects through multiple color layers. Based on archaeological findings and in-depth research, this paper comprehensively analyzes the contradictory unity between the "black" of lacquer art and the "colors" of painted sculpture from three perspectives: cultural semiotics, craft characteristics, and aesthetic experience. It attempts to demonstrate the dialectical relationship manifested when the two integrate in materials, reconcile in aesthetics, and infiltrate in culture. Such analysis not only deepens the understanding of the underlying principles of traditional handicrafts but also provides credible theoretical support and guidance for the sustainable development and improvement of traditional crafts in modern society.

Keywords
Lacquer art; Painted sculpture; Black; Colors; Dialectical relationship; Traditional crafts

1. Introduction

Lacquer art and painted sculpture are two cornerstones of traditional plastic arts. Their origins can be traced back to distant historical periods, and after long-term accumulation and development, they have formed a unique artistic system rich in profound cultural heritage and aesthetic characteristics. Lacquer art uses natural lacquer as the main raw material, and in its color expression system, "black" is particularly prominent—a feature that has persisted from ancient times to the present. From the red-lacquered wooden bowl unearthed at the Hemudu Site to the Qin and Han dynasties' tradition of "black exterior and red interior" lacquerware, black is not only the most striking visual highlight of lacquer art but also the key to its cultural value and craft aesthetics. Painted sculpture uses clay or porcelain clay as the base material, and artists apply multi-layered color rendering with various mineral pigments to create brilliant and rich visual effects. The Dunhuang painted sculptures have 72 carefully formulated color sequences, and the painted sculptures in the Shengmu Hall of Jinci Temple take blue-

green as the main color tone, which well reflects the uniqueness and profound connotation of painted sculpture art in color expression.

Currently, most studies focus on the innovation and investigation of lacquer art craftsmanship. Xu (2024) explored the innovative application of traditional lacquer art in contemporary sculpture creation, and Guo (2022) analyzed the color application principles of Dunhuang murals and painted sculptures. However, few studies on the color aesthetics of painted sculpture have conducted systematic research from the perspective of the dialectical relationship between the two colors. Based on detailed archaeological data and authoritative academic literature (Zhao et al., 2025; Yao, 2025), this paper explores the contradictory unity between the introverted characteristic of the "black" in lacquer art and the explicit characteristic of the "colors" in painted sculpture, attempting to provide a special theoretical perspective and application guidance for the cross-media integration and transformation of traditional art forms.

2. Cultural Connotation and Craft Characteristics of the "Black" in Lacquer Art

2.1 Cultural symbolism of "black" in lacquer art

In the field of lacquer art, black is a pure color form containing profound philosophical concepts and cultural implications of social hierarchy. From the perspective of Confucianism, black represents solemnity, orderliness, and decorum. When mixed with red, it forms the so-called "xuanxun" (dark red and black) color system, which occupied a very important position in lacquerware production from the Shang Dynasty to the Qing Dynasty. This reflects the inherent significance of etiquette systems and the ancient society's emphasis on the values of hierarchy and harmonious coexistence. From the perspective of Daoist philosophy, black represents the original, unadorned state of nature. The deep, lustrous color achieved through lacquering and polishing aligns with the aesthetic ideal of "the Dao models itself on nature," emphasizing the pursuit of inner tranquility by following natural laws. Archaeological evidence shows the central position of black in historical cultural heritage. For example, the double-layer nine-compartment lacquer cosmetics box unearthed from the Mawangdui Han Tomb, which uses pure black as the base color with vermilion lines outlining patterns, effectively demonstrates the solemnity and gravity of noble artifacts. Similarly, the Northern Song Dynasty lacquered Ashoka Pagoda excavated from the Baixiang Pagoda in Wenzhou uses a black lacquer surface as its foundation, incorporating gold thread inlays to achieve a harmonious unity between a solemn atmosphere and exquisite details, further showcasing the unique charm and symbolic significance of black in ancient craft design (Zhao et al., 2025).

2.2 Expression of "black" determined by craft characteristics

The unique material properties of natural lacquer endow black with a distinctive artistic expression form, which is highly charming both visually and tactilely. The black color produced by the oxidation of natural raw lacquer is warm and stable in texture, with high durability, and its vitality is far superior to chemical pigments (Wu & Xu, 2024). This is reflected in two aspects: first, its natural and environmentally friendly characteristics; second, it gradually shows rich layers and depth over time. In lacquer art, the multi-layered manifestation of black mostly relies on three key techniques: application, polishing, and inlay. The Pengxiu technique mixes black primer with metal powder and then undergoes careful polishing to produce a profound and layered texture effect, showing a gradient from light to dark. The inlay technique, by its nature, inlays colorful materials such as jade and mother-of-pearl into the black lacquer sur-

face, forming a distinct yet harmonious contrast between black and colors, and further enhancing the artistic appeal of the works. These craft characteristics make the black of lacquer art possess both unity and delicacy, laying a solid foundation for its integration with the colors of painted sculpture (Xie et al., 2025).

3. Aesthetic Characteristics and Cultural Expression of the "Colors" in Painted Sculpture

3.1 Construction of color spectrum and aesthetic pursuit of painted sculpture

The artistic expression of painted sculpture relies on mineral pigments as a key material, establishing a color system with decorative beauty and symbolic meaning. Guo (2022) elaborated on the color application of Dunhuang painted sculptures in his book "Traditional Chinese Colors: The Color Aesthetics of Dunhuang", which includes rich color combinations composed of 72 different colors. Most painted sculptures of the Western Wei Dynasty used ultramarine blue, malachite green, and bright red as the main colors. This choice appropriately integrated the unique charm of Western Regions culture with the traditional essence of Central Plains art, reflecting the artistic transformation under the integration of multiple cultures. By the Guiyi Army period, the color style of painted sculptures underwent obvious changes, adopting more stable sea blue and ochre colors. The use of these colors also reflected the changes in social aesthetic trends at that time and indicated the adaptation and continuous development of artistic expression forms in the historical context. The Northern Song Dynasty painted sculptures in the Shengmu Hall of Jinci Temple followed the creative principle of "three parts sculpture, seven parts painting". Their color application was mainly based on blue-green tones, integrated with vermilion and gold elements, striving to accurately reproduce the characteristics of Song Dynasty costume regulations. Through careful color contrast techniques, it vividly showed the hierarchical differences and personality traits among the sculpted figures.

Painted sculpture art emphasizes "expressing spirit through colors", a concept that is more evident in works of different themes. For example, the Dunhuang Bodhisattva statues use the color effect of dark blue hair and emerald green eyebrows to create a sacred atmosphere for the sculptures through distinct color contrasts. The maid statues convey the warmth and human touch of the world with soft and elegant makeup, thus reflecting the characteristics of Buddhist art that are both solemn and full of human emotions. The painted sculptures in the Baixiang Pagoda in Wenzhou integrated the local characteristic "Ousu" (Wenzhou sculpture) technique, using porcelain clay as the main material and pigments mixed with tung oil to achieve the unity of color and shape (Wu & Xu, 2024). The delicate depiction of gold lines not only optimized the overall beauty of the works but also added a strong classical and elegant atmosphere. Such color expression is conducive to the transmission of religious themes and humanistic narratives, and also forms a unique aesthetic value system.

3.2 Cultural context and technical support behind the colors

The choice of colors in painted sculpture is a key part of artistic decision-making, which is related to the context of the times and the innovation of material technology. Most of the mineral pigments used in Dunhuang painted sculptures came from commercial activities on the ancient Silk Road. The application of pigments such as ultramarine blue and ochre not only shows the sophistication of color aesthetics but also reflects the historical traces of cultural exchanges on the Silk Road. The Wenzhou painted sculptures of the Northern Song Dynasty showed the uniqueness of regional craftsmanship. The local use of special local porcelain

clay and tung oil mixed with pigments greatly improved the adhesion of the pigments and enhanced the durability of the colors (Wu & Xu, 2024). This is not only a technical improvement but also a manifestation of local artistic wisdom. From the perspective of cultural core, the colors of painted sculpture are full of strong religious meanings. Gold represents sacredness in Buddha statue sculpture and reflects strict hierarchical order, which can be confirmed by the careful use of colors on the phoenix crown and python robe under the Shengmu statue of Jinci Temple. It is also an intuitive expression of folk aesthetics. The colorful folk painted sculptures reflect the rich customs and aesthetic tendencies of various regions, thus forming a diverse and unified color cultural system (Yao, 2025).

4. Practice of the Dialectical Relationship Between the "Black" of Lacquer Art and the "Colors" of Painted Sculpture

4.1 Opposition: differences in aesthetic orientation and expression logic

Lacquer art prefers black, while painted sculpture values colors, and their aesthetic orientations are completely different. Lacquer art takes black as the main color tone, creating an introverted and profound artistic atmosphere, and expressing rich connotations through subtle changes in a single color, which embodies the Oriental aesthetic concept of "less is more". Painted sculpture regards a rich color system as the key, creating multi-layered visual effects through exquisite color contrast and harmonious matching, which well reflects the decorative art tradition of "complexity as beauty". Such differences essentially reflect the expansion of the scope of material application. Natural lacquer is warm to the touch and full of strong emotions, and even a single color can enhance and deepen the artistic conception (Xie et al., 2025; Yao, 2025); while the surface of clay sculpture is relatively rough, its expressiveness is limited, and it often needs a variety of colors to fill to make up for the shortage in visual communication.

From the perspective of logical expression, the black in lacquer art is an "inclusive base", and all decorative details develop in accordance with it. The luster of mother-of-pearl and the splendor of gold foil can only be fully displayed by relying on the black background. Painted sculpture is different. Its color application is a "dominant communication". Color is not only a visual element but also directly involved in the shaping of the work's narrative, and can clearly distinguish the identity, gender, and even hierarchy of characters through its rich changes. The Dunhuang painted sculptures effectively distinguish between gods and Buddhas and ordinary people, and between men and women through the depth and deployment of colors. Such contrasts are very distinct, thus endowing the two with unique and striking artistic characteristics and recognition.

4.2 Unity: material complementarity and aesthetic reconciliation

4.2.1 Practical exploration of material complementarity

Lacquer art and painted sculpture are traditional art forms with unique materials, thus showing natural complementarity. This complementarity promotes the in-depth integration of the two in craftsmanship, and achieves the harmony and unity of colors through the application of ingenious techniques, which also set off each other, thereby enriching their respective artistic expression and aesthetic value. Contemporary lacquer sculpture art has explored the technique of integrating the black base of bodiless lacquer art with the color presentation of painted sculpture, developing the aesthetic approach of "black lacquer as bone, colors as skin" (Xu,

2024). In the practical operation of integrating Fuzhou bodiless lacquerware with sculpture innovation, craftsmen first fully cover the sculpture surface with black lacquer, and then carefully apply colored lacquer to depict and decorate the details. This process organically combines the delicate texture of lacquer art with the colorful characteristics of painted sculpture, creating a unique artistic style that shows the warm texture of lacquerware while highlighting the color characteristics of painted sculpture, achieving the coordinated coexistence of materials and colors (Yao, 2025).

4.2.2 Historical cases of aesthetic reconciliation

In the field of ancient artistic practice, the "black" in lacquer art and the "colors" of painted sculpture merged with each other, forming a relatively complete aesthetic system and technical norms. Taking the archaeological findings of the Northern Song Dynasty painted sculptures and the lacquer Arya Amitabha Pagoda unearthed from the Baixiang Pagoda in Wenzhou as examples, the painted sculpture part cleverly adopted the gold-cutting technique, inlaying gold lines on the base, showing exquisite artistic techniques and luxurious visual effects; the lacquer Arya Amitabha Pagoda created a solemn and dignified atmosphere with its pure black lacquer surface (Zhao et al., 2025). These two works belong to the same era. By using the color contrast between "black" and "gold", they not only enhanced the sacredness of religious art but also strengthened the overall artistic influence through a strong visual impact. In the production of cloisonné Buddha statues, the black primer of lacquer art is combined with the mineral pigments used in painted sculpture. The primer has durability, which can make the colors not easy to fade for a long time (Xie et al., 2025). The variety of mineral pigments greatly improves the artistic expression of Buddha statues, achieving the unity of both "solemnity" and "vitality".

4.2.3 Symbiosis and commonality of cultural connotations

The cultural cores of the two have a high degree of similarity. The black in lacquer art has the characteristics of "solemnity and eternity", and the colors of painted sculpture show the breath of "life and sacredness". Both serve religious rituals and celebration activities (Yao, 2025). Through their unique visual language, they not only enhance the solemnity of the rituals but also deepen the participants' understanding of the meaning of life and sacred values, achieving in-depth cultural resonance and spiritual integration in cross-media expression. In terms of Dunhuang art, the profound black of lacquer offerings carries out comprehensive spatial color communication with the gorgeous colors around the painted Buddha statues. This contrast on the one hand highlights the calmness and tranquility of black, and on the other hand emphasizes the lightness and agility of colors, together creating a solemn and humanistic religious atmosphere. Looking back at the funeral art of the Qin and Han dynasties, the black and red colors of lacquerware have a strong visual contrast with the painted costumes of painted pottery figurines. This feature aims to reflect the philosophical concept of "treating the dead as the living" (Zhao et al., 2025; Yao, 2025).

5. Contemporary Value and Inheritance Enlightenment of the Dialectical Relationship

Exploring the dialectical interaction between the "black" in lacquer art and the "colors" in painted sculpture reflects the tension and harmonious unity contained in it. This in-depth connection not only enriches the cultural connotation of traditional crafts but also provides important theoretical and application guidance for the innovation and development of contem-

porary traditional crafts (Yao, 2025; Wu, 2022). In terms of cross-media integration, modern lacquer sculpture art cleverly uses the dialectical thinking of "black base with colors", combining the profound black texture with the specific images of painted sculpture (Wu, 2022). This can not only retain the main characteristics of traditional crafts but also create a unique expression form with contemporary artistic style (Yao, 2025).

From the perspective of cultural inheritance, this dialectical relationship well reflects the aesthetic core of "harmony in diversity" of traditional art. The black elements in lacquer art reflect the stability and remoteness of the cultural foundation, and the various colors of painted sculpture show the diversity and transformation of cultural expression (Yao, 2025). The two reconcile and coexist, not only showing the unique charm of traditional crafts but also forming a sustainable development path for the living inheritance of this craft (Yao, 2025; Ding, 2025).

From a practical perspective, the integration of Fuzhou bodiless lacquerware with the local sculpture industry reflects the great market value of the dialectical unity of "black" and "colors" (Yao, 2025). This example enables us to deeply understand and verify the possibility of the innovation and integration of traditional cultural elements in the modern economic context. The digital protection measures of Dunhuang painted sculpture colors are creatively linked with the black techniques of lacquer art, establishing a solid technical foundation for the inheritance and transformation of traditional color culture in modern society (Xie et al., 2025; Yao, 2025). For future research directions, we can further explore the principles of integrating the color wisdom of traditional crafts with modern design, public art and other fields, so as to promote the transformation vitality of traditional crafts in the contemporary social environment, tap their application potential, and thus add new life connotations and cultural values (Yao, 2025; Wu, 2022).

6. Conclusion

There is a dialectical relationship between the "black" in lacquer art and the "colors" in painted sculpture. This relationship can be said to be a specific manifestation of Oriental aesthetic concepts such as "upholding tradition and innovating", "introversion and extroversion", and "simplicity and diversity". The black of lacquer art is calm and rich in cultural connotations, laying a stable aesthetic foundation for the color system of painted sculpture. The colors of painted sculpture have rich and varied expression forms and strong visual impact, adding vitality to the black of lacquer art. The two cooperate with each other in the process of craftsmanship, verify each other in cultural significance, and blend with each other in aesthetic considerations , together forming a complex and rich network system of color dialectics in traditional Chinese plastic arts.

This dialectical relationship reflects the key point of the operational wisdom of ancient artists, and is also the main guiding concept for the inheritance and innovation of traditional crafts in the present. That is, we must preserve the unique characteristics of our national crafts, and through the mutual enrichment and integration of various art forms, it is possible to inherit the traditional cultural values and aesthetic tastes in modern society, add new vitality, and thus achieve the modern transformation and sustainable development of traditional art.

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Reflections on Middle School English Education in Hainan Province from the Perspective of Post-Method Pedagogy

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Abstract

The talent demand driven by the construction of Hainan Free Trade Port has posed new requirements for English education. However, Hainan Province itself features a weak educational foundation and unbalanced development across regions. Despite undergoing multiple rounds of curriculum and teaching reforms, middle school English education in the province has yet to achieve satisfactory outcomes. To address the existing problems in Hainan's middle school English education, this paper, with reference to the three core parameters of B. Kumaravadivelu's post-method pedagogy—particularity, practicality, and possibility—discusses the unique challenges confronting English education in Hainan, the professional development of teachers and the upgrading of educational concepts, as well as the integration of social factors into classroom teaching to foster students' distinctive identities. The purpose of this study is to explore the enlightenment of the post-method perspective and provide reference for the development of English education in Hainan.

Keywords

Post-method pedagogy; Hainan; Middle school English education; Teacher professional development

1. Introduction

English, as a subject, and English education have long been a source of controversy across all educational stages and regions in China. For decades, proposals to abolish English as a core subject, or even to eliminate the subject entirely, are not uncommon. The "high input" yet "low output" of English education, coupled with the constant changes in teaching methodologies, have inevitably led people to question: Is there an optimal English teaching method?

Kumaravadivelu (1994), a professor at San Jose State University in the United States, synthesized previous language teaching methodologies as well as the criticisms and reflections on the "method" and its value put forward by scholars such as Freeman, Stern, and Allwright, and proposed the language education paradigm of Postmethod Pedagogy. Building on Stern's three-dimensional framework and Allwright's Exploratory Practice framework, Kumaravadivelu developed his own macrostrategic framework by integrating post-structuralist, postmodernist, and postcolonialist thoughts from cultural studies. Unlike the prior trend of substituting one approach for another (i.e., the "alternative method" paradigm), Kumaravadivelu advocated replacing the "method" with a new system or framework, whose core tenets can be encap-

sulated in three parameters and ten macrostrategies (Kumaravadivelu, 2006), as illustrated in the following figure:

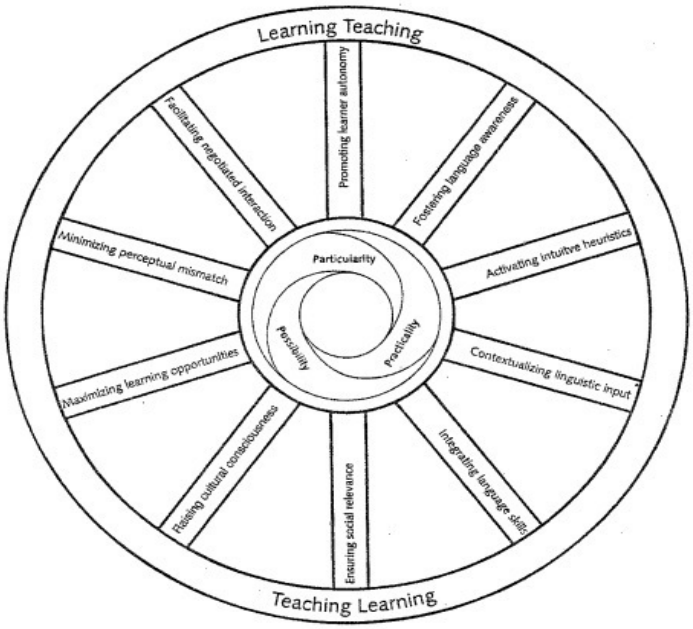

Figure 1 Pedagogic wheel (Kumaravadivelu, 2003:41)

Among these components, the three parameters serve as the foundational core, mutually shaping and influencing one another, with the holistic entity formed by their interactions far greater than the sum of their individual effects (Kumaravadivelu, 2006). To enhance the operationalizability of his theoretical framework, the ten macrostrategies proposed therein can also be extended into a specific set of microstrategies. These microstrategies are designed to facilitate teachers' application in classroom settings and support students in accomplishing language learning tasks.

Since the proposal of the post-method pedagogy, numerous scholars in China have conducted research on its connotations, feasibility, and value. Dong Jinwei (2008) pointed out that this pedagogical perspective offers valuable insights for foreign language teaching in China, while emphasizing the need for teachers to develop context-specific microstrategies tailored to their own classroom realities. Zhang Hong and Wang Qiang (2010) discussed teachers' autonomous professional development in the post-method era, stressing that "genuine educational reform must entrust teachers with decision-making responsibilities and full autonomy in educational practices."

Guided by these theoretical studies, the application and research of post-method pedagogy have been on the rise in China, yet they are predominantly concentrated in research areas such as foreign language teaching in institutions of higher education, teaching Chinese (as a second language), and pedagogical studies. Ma Ruiying (2013) introduced the core tenets of post-method theory, referring to it as a "framework emphasizing openness and creativity," and identified its implications for college English teaching from three dimensions: reflective and autonomous teachers, independent and collaborative learners, and the compilation of textbooks aligned with China's national context. Zhong Caihong and Hu Rongjie (2020) analyzed the strengths and limitations of post-method pedagogy, arguing that in the context of teaching Chinese as a second language, post-method merely "wears a foreign hat"—a metaphor implying its superficial adoption without substantive localization.

Research on the application of post-method pedagogy in middle school English teaching remains scarce; furthermore, existing studies are primarily conducted in relatively developed educational regions and mostly presented as master's theses. For instance, Zhou Xiaolan (2018) investigated the needs of regular high school English learners, taking high schools in Hangzhou as a case study; Zhou Jia (2017) conducted research on reflective teaching among high school English teachers, using a high school in Nanjing as an example; and Fu Rong (2020) explored post-method-based English writing teaching in senior high schools, focusing on students from Liaodongwan High School. However, to date, research on the cultivation of educational concepts, teaching methodologies, and teacher development in Hainan's foreign language education from the perspective of post-method pedagogy remains a gap in the literature. The present study attempts to reflect on the challenges and existing problems in Hainan's foreign language education based on post-method pedagogy, particularly from the perspective of its three core parameters, and to identify the implications for educational development.

2. Unique Challenges Confronting Hainan's Education from the Post-method Perspective

Hainan Province, characterized by its unique geographical location, relatively small population, modest economic scale, and underdeveloped status, ranks fourth from the bottom among all provincial-level administrative regions in mainland China (excluding Hong Kong, Macao, and Taiwan) in terms of land area, total population, and GDP volume as of 2022. Meanwhile, the development orientation of Hainan Province is significantly shaped by national policies. Currently, the educational development of Hainan Province is confronted with three major challenges, namely the evolving development situation, the disadvantaged academic foundation of students, and the contemporary context.

2.1 Development situation of Hainan province

Endowed with a unique geographical location and functioning as a relatively independent geographical unit, Hainan Province has served as a national pilot zone for development since its establishment as a province. As one of China's earliest special economic zones, Hainan has achieved rapid development compared to its past, yet it has also experienced twists and turns and currently remains at a relatively low developmental level when compared to other regions. In April 2018, General Secretary Xi Jinping proposed the construction of the Hainan Free Trade Port (FTP), paving a new path for Hainan's development. In accordance with the Overall Plan for the Construction of the Hainan Free Trade Port, Hainan Province is scheduled to launch full-island customs closure operations in December 2025, emerging as a new window for China's foreign trade and exchanges.

To intensify opening-up efforts, attract more foreign investment and international trade, and develop high-end tourism, modern services, medical care, education, and other sectors, Hainan's international communications will increase substantially. Consequently, the demand for foreign language professionals in Hainan, particularly interdisciplinary talents with a strong foreign language background, will rise significantly. The education sector bears the responsibility of cultivating talents for national development; therefore, foreign language education in Hainan must align with the needs of FTP construction to nurture socialist builders who possess proficient language abilities, specialized professional knowledge, as well as social responsibility and patriotic sentiments.

Furthermore, influenced by the policy in the high school entrance examination (where approx-

imately half of the candidates proceed to high schools and the other half to vocational schools) and college admission rates, a considerable proportion of students are unable to pursue higher education. As future builders of Hainan, their English education primarily takes place during the primary and secondary school stages. However, compared to regions with advanced international trade such as Hong Kong (China) and Singapore, the overall foreign language proficiency of Hainan's general population—including these educated groups—remains relatively weak. Thus, the popularization and improvement of foreign language competence constitute a key priority in primary and secondary foreign language education in Hainan.

2.2 Disadvantaged academic foundation of students in Hainan

Hainan Province is confronted with new missions in English teaching, yet the overall actual competence of students remains at a unsatisfactory level. Constrained by factors such as geographical location and economic development, the educational undertakings in Hainan lag behind those in other regions of China. With national support, the school-running conditions of various educational institutions have been significantly improved, but gaps persist in terms of teacher quality and teaching philosophies. Within Hainan Province, there are distinct regional disparities in educational resources, development levels, and student quality—Haikou, Sanya, and Wenchang have achieved far higher development than other areas, particularly the Li and Miao ethnic minority regions.

As a crucial evaluation tool for secondary education, the performance in examinations such as the National College Entrance Examination (Gaokao) largely reflects the overall educational quality. Over the past three years, in the assessments, the average English score of Hainan Province has consistently fallen below 60 points (out of 150), with an achievement rate of less than 40%. Notably, the score rate in objective questions has been significantly higher than that in subjective questions, especially in the "Continuation writing" section, where the achievement rate is only around 25%. Objective English questions are mainly multiple-choice with optional answers, allowing students a certain probability of scoring based on guesswork or partial understanding. In contrast, subjective questions are more capable of reflecting students' true linguistic proficiency. The low scores in subjective sections indicate insufficient comprehensive language abilities among students, which are far from meeting the corresponding national competency requirements.

Beyond the generally low educational level, there are also substantial disparities between schools across different regions of Hainan. Taking the 2025 Tianyi Joint Examination in Hainan as an example—with a full score of 150 and 116 participating schools—only 5 schools achieved an average score above 90 points. Among these, 3 are located in Haikou (including 2 jointly-run schools), 1 in Sanya (a jointly-run school), and 1 in Wanning (a jointly-run school). Schools with an average score above 60 points are concentrated in Haikou, Sanya, Wenchang, and other jointly-run institutions. In contrast, schools in other regions, especially ethnic minority areas, generally achieved comparatively lower scores, which reflects an imbalanced educational development across regions with distinct geographical characteristics.

2.3 The contemporary context

The development of the times and advances in science and technology have brought opportunities to the cause of education, accompanied by concurrent challenges. Under the current international context, we are facing an unprecedented situation unseen in any previous era. The impact of the COVID-19 pandemic has not been fully eradicated, with globalization and deglobalization contending repeatedly, and persistent increases in unstable factors in the in-

ternational political and economic landscape. Meanwhile, technologies such as computing, the Internet, and artificial intelligence (AI) have posed new requirements for education. Since 2023, AI tools trained on large language models (LLMs), represented by ChatGPT, have demonstrated exceptional capabilities in teaching, translation, writing, scientific research, and other fields. As an academic discipline characterized by both instrumental and humanistic values, the instrumental function of English is increasingly susceptible to replacement by AI. Therefore, teachers must recognize the profound significance of reform: if they adhere rigidly to traditional language teaching methods, focus solely on linguistic competence, and fail to foster students' core competencies in an all-round manner—especially their higher-order thinking skills—the graduates cultivated will lack competitiveness in the age of AI.

In summary, Hainan Province faces dual pressures: internally, the demand for English-proficient talents driven by the construction of the Free Trade Port (FTP) amid relatively underdeveloped educational foundations; externally, the impacts of a grim international situation and technological disruptions such as AI. The development of education in Hainan is distinct from that in other regions and eras, featuring unique local characteristics. The particularity parameter of the post-method pedagogy posits that no single teaching method is universally applicable. Instructional approaches must be localized, derived from teachers' classroom experiences, local students' academic backgrounds, and regional educational realities. Simply replicating others' methods and theories will merely impose an additional burden on teachers without improving teaching effectiveness. Methods effective in other periods may not be applicable today; those suitable for other regions may not work in Hainan; and even within Hainan, appropriate approaches vary across different areas. Thus, the blind promotion of a single teaching method is meaningless, and the pursuit of a uniform pedagogical model across all grade levels and subjects in certain regions is even more inadvisable. The promotion of educational concepts and teaching methods is generally driven top-down by educational authorities and school administrators, as a result of policy-related factors. However, teachers themselves need to fundamentally understand the relationship between teaching methods and practice, develop their own educational philosophies, and promote their professional growth.

3. Teachers' Professional Development from the Perspective of Post-Method Pedagogy

As organizers of teaching activities and practitioners of pedagogical theories, middle school teachers have long faced a predicament characterized by insufficient theoretical guidance and the disconnect between theory and practice, which hinders their ability to effectively guide teaching practice. Deficiencies still exist in teachers' self-construction and renewal of educational philosophies, selection of teaching methods, and professional development.

3.1 Educational philosophies

Constrained by their educational backgrounds and job responsibilities, primary and secondary school teachers often occupy a subordinate position in terms of pedagogy and methodologies, while educational experts and scholars stand in a dominant position. Specifically, experts formulate or propose theoretical frameworks, which teachers are expected to implement in their teaching practice—yet teachers can only passively accept such theories. As frontline practitioners of teaching theories, teachers are compelled to adopt new theories and methodologies under the pressures of policies and administrative promotions amid successive rounds of educational reforms. Hainan Province, serving as a national pilot zone for development, has participated in four rounds of foreign language education reforms, including the new college

entrance examination (Gaokao) model launched in 2019. As Chen Xiangming (2003: 110) argues, "Teachers have become consumers of knowledge, passively consuming the knowledge produced by experts. The richer and more complex educational research outcomes, the simpler and more rigid teachers' thinking." Teachers themselves are unable to question or innovate upon existing theories, nor can they implement practical and effective teaching methods tailored to the actual dynamics of their classrooms.

Beyond domestic experts, countries such as the United Kingdom, the United States, and Canada — endowed with the advantage of English as their mother tongue — possess greater authority, with their English teaching theories and methodologies occupying a dominant position globally. Teaching methods developed based on foreign theories exhibit significant discrepancies from the actual classroom contexts of domestic teachers, making it difficult for teachers to apply them effectively in practice.

Although educational administrative departments organize various training programs on teaching theories and methodologies for frontline teachers, most teachers still struggle to develop their own systematic educational theoretical frameworks.

3.2 Teacher training

To promote teachers' professional development, educational authorities schools have organized various training activities aimed at disseminating new educational philosophies and facilitating the implementation of teaching reforms. Currently, except for a handful of teachers who have access to training programs such as exchanges and academic visits, most teacher training initiatives in Hainan Province mainly include online lectures, online training programs, offline seminars, workshops, and master teacher studios. The training content features insufficient focus on enhancing educational philosophies; instead, it primarily involves educational experts and scholars indoctrinating frontline teachers with educational theories or sharing teaching methodologies. Teachers who actually participate in these programs still passively accept what have been given while many merely engage in the training to fulfill tasks and obtain credits without devoting genuine effort to mastering the content. Coupled with the lack of effective assessment mechanisms, these training programs have not yielded as many results. Teachers still have few opportunities for effective two-way communication with educational experts and insufficient understanding of methods to promote self-improvement and professional growth.

3.3 Teachers' professional growth

Affected by the realities of teaching practice, the guiding role of theoretical knowledge for middle school teachers has gradually weakened since they embarked on their careers. Their self-development and professional growth largely rely on various teaching skills training, the transfer of experience and skills from senior colleagues, and continuous self-experimentation. However, the experience gained through these training programs, learning processes, and trials lacks systematicity, failing to effectively facilitate teachers' professional growth. While many teachers smoothly transition from novice teachers to proficient teachers and further to competent teachers, very few progress to become expert teachers or master teachers, which stems precisely from the lack of in-depth reflection and summarization of their own teaching practices, as well as the failure to theorize their experiences and approaches.

The practicality parameter of post-method pedagogy emphasizes that teachers' educational philosophies should be derived from the summarization and reflection on their own teaching

practices, thereby truly achieving "theorizing practice and practicing theory." Kumaravadivelu (1994) argues that action research, based on classroom discourse analysis, self-observation, and self-evaluation, can enhance teachers' research capabilities, improve practical effectiveness, and enable the formulation of corresponding micro-strategies in line with its macro-strategic framework. Compared with other research methods, action research features a relatively low threshold and strong operability, making it a crucial means for teacher development. Nevertheless, currently, there is a scarcity of action research in primary and secondary schools in Hainan, and no context-specific educational philosophies have been formed that align with the actual teaching conditions of schools and originate from teachers' own practices.

The practicality parameter of post-method pedagogy shares similarities with the research on practical knowledge conducted by Chen Xiangming's team at Peking University. Through studies on excellent primary and secondary school teachers, the team identified that these teachers possess practical knowledge, which they defined as "teachers' understanding of education and teaching formed through reflecting on and refining their own educational and teaching experiences, and manifested through their actions" (Wei & Chen, 2018). However, the research objects of their team were mainly excellent teachers rather than novice teachers. In response to external doubts regarding this, Chen Xiangming (2018) stated, "The reason for exploring practical knowledge among outstanding senior teachers is that this group possesses the awareness and ability to reflect and accumulate, resulting in relatively rich and stable practical knowledge." This indicates that excellent teachers have more abundant practical knowledge compared to novice teachers. For novice teachers to grow into excellent educators, an important pathway lies in strengthening action research, observing and reflecting on their classroom teaching activities, refining their ideological understanding, and using this to improve their teaching and form their own unique practical knowledge. This also points out a new direction for the professional development of middle school teachers in Hainan: compared with training on educational philosophies and teaching methods, more practical approaches such as action research and case study should be prioritized in training programs. These methods will assist primary and secondary school teachers in developing their own theories through practice, forming practical knowledge, improving classroom teaching, and achieving personal growth simultaneously.

4. Connotations of Classroom Teaching from the Perspective of Post-Method Pedagogy

Language serves not only as a carrier of culture and consciousness but also as a tool for their dissemination. Kumaravadivelu (2006: 200) argues that in the process of language learning, there exists no purely linguistic environment that is completely unaffected by social, political, historical, cultural, and other factors. Therefore, in the teaching process, teachers must take into account the learning needs of language learners and the social context in which language teaching takes place, correctly handle the relationship between teaching and other influencing factors, leverage the inherent advantages of language education in addressing values and ideological issues, and cultivate students with distinct personal identities. Faced with the special educational situation and needs in Hainan, teachers can make improvements at the following three levels:

4.1 Enriching the connotations of classroom teaching

In addition to existing textbooks and classroom activities, teachers can expand the connotation of classroom teaching and activities in response to the demands of social development and

students' educational needs. Hainan's unique geographical environment, historical culture, as well as the distinctive humanistic elements of various regions, can all be integrated into classroom teaching. The construction of the FTP requires interdisciplinary talents with strong language application capabilities; therefore, classroom teaching should also strengthen the cultivation of students' language output competence and pragmatic competence, so as to truly meet the needs of students' personal growth and social development.

4.2 Emphasizing ideological and political education in curriculum

Currently, in the English curriculum standards implemented in primary and secondary schools in China, language learning is conducted based on discourses. Through discourse learning, students are required to master cultural knowledge and identify and judge the attitudes and values embedded in discourses (Ministry of Education, 2022). When selecting teaching materials, teachers should not only focus on linguistic knowledge but also incorporate ideological and political education elements, thereby implementing ideological guidance. Teachers should guide students to establish correct values through discourse learning, develop a proper understanding of socialism, Chinese civilization, and world civilizations, adopt a critical attitude towards foreign cultures, and cultivate students' cultural confidence and institutional confidence. Ultimately, this approach aims to truly cultivate talents needed for China's socialist modernization drive and the construction of Hainan FTP.

4.3 Cultivating students with Hainan's distinctive traits

Language learning also enables students to gain a better understanding of themselves. Kumaravadivelu (2001) argues that language education not only presents challenges for learners but also provides opportunities for them to continuously pursue autonomy and construct their self-identity. Through language learning classrooms infused with Hainan's distinctive historical and cultural connotations as well as local humanistic elements, coupled with the subtle influence on students' ideological awareness, Hainan students will develop their unique identity characteristics, evolving into individuals embodying the distinctive traits of being "healthy and optimistic, eager to learn and progress, diligent and honest, and civilized and humble."

5. Conclusion

There exists a contradiction between the demand for talents driven by the construction of Hainan Free Trade Port and the current development status of English education in Hainan Province. Despite undergoing multiple rounds of educational reforms, Hainan has achieved limited results in most cases. Kumaravadivelu's post-method pedagogy reflects on the concept of "method," and its three core parameters—particularity, practicality, and possibility—hold strong guiding significance for the development of English education in Hainan. Foreign language education in Hainan should formulate corresponding teaching strategies based on the specific circumstances of educational institutions at different levels. Meanwhile, teachers' instructional methods ought to be grounded in the actual dynamics of their classrooms; through approaches such as action research, teachers can reflect on their practice, develop their own practical knowledge, and achieve professional self-development. In classroom teaching, social development needs and students' individual demands should be integrated into curriculum elements. Ideological guidance should be conducted through language learning to help students form unique identity characteristics and cultivate talents required for national construction.

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Media Liberation and Reconstruction: The Ontological Transformation of Contemporary Lacquer Art

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Abstract

Contemporary lacquer art faces a critical juncture. Its modernization cannot be achieved through superficial updates of visual motifs or simple functional shifts. Instead, what's needed is a fundamental restructuring of the medium's ontological foundations. This study examines how modern lacquer painting can achieve genuine autonomy by breaking free from its historical subordination to vessel-based forms. Through analysis of contemporary practices and theoretical engagement with material agency and medium specificity, this research identifies two major obstacles: technical fetishism (excessive focus on virtuosic craftsmanship over conceptual innovation) and medium aphasia (uncritical borrowing from other artistic traditions). The investigation of technical deconstruction processes—gestural mark-making, textural materialization, and subtractive aesthetics—reveals an emerging visual language rooted in lacquer's intrinsic material properties. The findings demonstrate that deliberate deconstruction of conventional techniques enables reconstruction of aesthetic systems that bridge Eastern philosophical traditions with contemporary visual experience, establishing lacquer art's distinct position in global contemporary practice.

Keywords
Lacquer art; Material ontology; Medium specificity; Technical deconstruction; Contemporary Chinese art

1. Introduction

For eight millennia, Chinese lacquer art has centered on what we might call "object adornment"—a sophisticated craft system devoted to enhancing functional vessels. But the twentieth century changed everything. Industrialization and Western modernist influences triggered an identity crisis that questioned the very foundations of lacquer's cultural value (Song et al., 2019; Zhang & Liu, 2020). This crisis gave birth to "modern lacquer painting," an ambitious attempt to liberate lacquer from utilitarian constraints and establish it as an independent artistic medium on par with recognized fine art forms (Xu, 2024).

Yet contemporary lacquer painting struggles with what might be termed "ontological dislocation." Practitioners aspire to the subjective expression and spiritual depth of modern painting,

but they must contend with lacquer's stubborn material realities: prolonged drying cycles, rigid layering requirements, laborious production processes (Tang & Yu, 2022). Unlike oil painting's straightforward layering or ink wash's spontaneity, lacquer painting is slow, uncertain, mediated by complex material workflows. This tension—between the desire for free expression and the discipline of craftsmanship—lies at the heart of contemporary lacquer practice.

This study proposes moving beyond conventional heritage preservation discourse. Rather than simply safeguarding techniques as "intangible cultural heritage," the research asks: How can traditional lacquer craftsmanship transform into an autonomous artistic language with genuine aesthetic value in contemporary contexts? This transformation involves not just material expression but fundamental restructuring of creative thinking, viewing paradigms, and value systems.

2. Theoretical Positioning

2.1 Material agency in lacquer practice

Recent developments in new materialism offer productive ways to think about lacquer. Instead of viewing lacquer as passive substrate, it can be recognized as an agentive material with intrinsic behavioral patterns, temporal rhythms, transformative potentials. Lacquer's properties—viscosity, photosensitivity, extended curing requirements, environmental sensitivity—function not merely as technical constraints but as generative parameters that shape aesthetic possibilities (Song et al., 2023).

This reorientation shifts focus from artist-centered intentionality to distributed agency across human-material assemblages. The artist doesn't simply impose form on passive material; rather, form emerges through ongoing dialogue between practitioner and material. Each layer of lacquer has its own temporality, its own responsiveness to environmental conditions, its own resistance and affordances.

2.2 Medium specificity reconsidered

The concept of medium specificity provides crucial grounding for understanding lacquer's contemporary trajectory. However, this discussion requires careful navigation. The analysis here does not invoke essentialist definitions that reduce each medium to its supposed "purity." Rather, lacquer's unique material properties enable what might be called "differential specificity"—a medium identity constituted through distinctive technical supports and material behaviors rather than predetermined essential characteristics.

This framework allows theorization of lacquer's modernization as neither nostalgic essentialism nor radical abandonment of material essence, but rather critical reinvention of medium-specific practices responsive to contemporary aesthetic conditions. Lacquer remains lacquer not because it adheres to some timeless essence, but because its particular materiality continues to generate distinctive aesthetic possibilities.

2.3 Two methodological deviations

Current lacquer practice exhibits two problematic tendencies that impede productive modernization:

First, technical fetishism. Traditional techniques—carved red lacquer, mother-of-pearl inlay,

sprinkled gold—represent extraordinary craftsmanship and cultural heritage. But when technical complexity becomes valorized independent of conceptual content, works devolve into mere demonstrations of skill (Liu & Ren, 2021). The "how" overshadows the "what" and "why," reducing artistic practice to craft exhibition.

Second, medium aphasia. Some practitioners uncritically appropriate compositional schemas from oil painting, ink wash, or printmaking, reducing lacquer to pigmented coating or surface treatment (Yin & Chen, 2023). This evacuates lacquer's phenomenological distinctiveness—its translucency, deep luster, tactile warmth achieved through iterative polishing. Such derivative practices fail to establish genuinely distinctive contributions to contemporary aesthetics.

3. Methodology

This investigation combines theoretical analysis, technical examination, and comparative case studies. Contemporary lacquer practices were analyzed through three analytical categories that emerged inductively from sustained observation: gestural agency (mark-making versus coating), material texture (decoration versus spiritualization), and subtractive aesthetics (grinding philosophy).

Case selection followed specific criteria: innovative technical approaches demonstrating material deconstruction, critical recognition within contemporary discourse, substantial bodies of work evidencing consistent methodology, and accessible documentation enabling rigorous analysis. This allowed identification of representative practitioners whose work exemplifies distinct modernization strategies.

4. Technical Deconstruction and Reconstruction

4.1 From coating to calligraphic mark

Traditional lacquerware aesthetics emphasized flawless, mirror-smooth surfaces—a standard that effectively erased visible traces of manual intervention. The creator's hand disappeared into perfect finish. Contemporary practice deliberately disrupts this convention through what might be termed "gestural inscription"—a shift from concealing to revealing bodily presence.

Raw lacquer's high viscosity naturally resists the fluid brushwork of ink calligraphy. Yet contemporary practitioners have developed innovative "rough brush grammar" through material reformulation (mixing tung oil to reduce viscosity) and environmental control. This technical innovation enables dynamic imprinting of bodily movement onto material surfaces. Lacquer transitions from passive coating to active medium for writing. Finished works no longer conceal but actively manifest traces of artistic presence, imbuing objects with perceptible expressive vitality.

4.2 From pattern to texture

Traditional "bian tu" (transformative coating) techniques—exemplified by rhinoceros skin lacquer—originally served mimetic or ornamental functions. Contemporary practice radically reinterprets these as abstract "textural language." What were previously considered flaws—shrinkage, cracking, wrinkling during curing—become primary expressive media.

Through precise environmental manipulation (temperature, humidity control), artists guide lacquer's natural behaviors to generate specific textural formations. These patterns evoke geo-

logical sedimentation, erosion marks, organic growth-decay cycles. Materials cease being passive carriers; they transform into autonomous co-creators. Resulting surface textures transcend decoration, becoming narrative vehicles that convey temporal passage, material dissolution, vital resilience through simultaneous visual and haptic dimensions.

This elevates lacquer's physical properties to spiritual metaphors, establishing dialogues among materials, natural processes, and cultural meaning-making. The approach resonates with Taoist philosophical traditions emphasizing wu-wei (non-purposive action) and material spontaneity.

4.3 Grinding as archaeological practice

Traditional polishing pursued ultimate perfection—jade-like smoothness embodying Eastern aesthetic ideals. Contemporary practice reinterprets grinding as "subtractive aesthetics." Rather than seeking flawless surfaces, artists deliberately reveal concealed temporal strata and material memories through controlled surface removal.

Each removed layer functions as temporal capsule. Previously hidden colors, textures, brushstrokes reemerge into perceptual fields, forming richly layered narrative structures that reconstruct creative trajectories from foundation to surface, inception to completion. This subtractive process establishes dynamic dialectics between concealment and revelation: each layering simultaneously obscures preceding phases while creating potential for subsequent disclosure.

Works acquire temporal depth and historical resonance. Polishing transcends terminal finishing, becoming archaeological practice—artists employ grinding as excavational tool, visually uncovering traces and unintended effects formed during creation within material substrates. Spontaneous textures—flowing pigments, accidental bubbles, stratified fractures—cease being perceived as defects. They're embraced as organic components. This deliberate integration of randomness and process traces enables lacquer to maintain traditional materials while radiating contemporary vitality.

5. Case Analysis

5.1 Abstract material cosmos

Artists like Su Xing and Tang Zhiyi exemplify movement toward abstract creation that grants materials autonomous narrative agency. Through deliberate deconstruction of conventional layering and mosaic techniques, they investigate intricate interactions among lacquer, metal foil, and mineral pigments.

Their works construct autonomous visual realms—sometimes suggesting infinite cosmic expanse, other times evoking primordial chaos and emergence. Central to these creations is profound focus on rhythmic light-texture variations, generating dynamic visual pulses across material surfaces and underlying structures. This material exploration engages Western Abstract Expressionism while remaining rooted in Eastern lacquer's material genetics. Their artworks generate immersive, meditative spaces inviting contemplative engagement with materials, forms, and perceptual experience.

5.2 Figurative material landscape

Cheng Xiangjun demonstrates how lacquer revitalizes figurative painting through innovative

material deployment. In his practice, lacquer transcends conventional material status, evolving into expressive medium that reinterprets natural structures through contemporary perspectives. Rather than focusing on representational accuracy, Cheng harnesses lacquer's unique properties—viscosity, malleability, density—to meticulously reconstruct earth's internal frameworks and geological formations.

His technical approach synthesizes printmaking's decisive knife marks with lacquer's layered depth, forging distinctive personal visual language. This methodology avoids superficial illustration, instead transforming nature's visual weight into palpable tactile weight through medium's inherent physicality. Viewers perceive almost tangible textures through purely visual means. His works testify how traditional craftsmanship, subjected to conceptual transformation, offers unique tactile expression.

5.3 Divergent strategies

These approaches reveal complementary pathways toward modernization. Some practitioners pursue material abstraction, privileging lacquer's intrinsic behavioral patterns over representational content. Others maintain figurative reference while fundamentally transforming representation through material specificity. Both strategies share commitment to material agency and resistance to derivative appropriation, yet differ in balancing abstraction versus figuration, spontaneity versus control, Eastern versus Western frameworks.

6. Cultural Implications

6.1 Eastern aesthetics in global context

Lacquer's modernization represents sophisticated evolution within Eastern traditions rather than simple departure. Core values—restraint (hanxu) privileging subtlety and implication; warmth (wenrun) conveying gentle, harmonious material presence; appreciation for quiet refinement—are consciously positioned in productive tension with Western modernist expressivity (Yang & Xie, 2022).

This comparison functions not as dismissal of Western traditions but as invitation to complementary cross-cultural dialogue. Through innovative approaches and conceptual depth, contemporary lacquer artists translate ancient philosophical tenets into universally resonant visual language. This demonstrates that cultural specificity can serve as gateway to global relevance rather than barrier.

Contemporary lacquer illustrates that "Chineseness" in artistic practice need not rely solely on archaic motifs or stereotyped symbols. It manifests through distinctive sensibility—particular regard for natural materials' beauty, patient engagement with time-intensive processes, fundamentally contemplative worldview valuing depth over immediacy. Contemporary lacquer offers vital Chinese perspective, contributing meaningfully to diverse, pluralistic global contemporary landscape.

6.2 Embodied cognition and craft

In the digital era, traditional "craftsman spirit" requires significant reinterpretation beyond simplistic associations with diligence. This study proposes reconceptualizing it as "embodied cognition"—dynamic process where knowledge, skill, and meaning are rooted in physical practice and sensory experience.

Lacquer production demands months or years of sustained physical engagement, unwavering patience, meticulous attention to minute details (Song et al., 2019). Such immersive practice constitutes meaningful resistance against alienation and ephemeral shallowness characterizing rapid virtual production methods increasingly dominating modern life. Through artists' intimate, ongoing dialogue with materials—relationships built on touch, sight, deep understanding of possibilities and constraints—richer forms of spiritual and cognitive cultivation emerge.

This tactile, deliberate, inherently slow art form serves as vital humanistic anchor in unprecedented accelerating world. It reminds observers that despite relentless technological advancement, most profound aesthetic experiences remain rooted in direct sensory, physical interaction between human body and enduring, tangible material world.

7. Conclusion

Lacquer art's modernization fundamentally represents dialogue between material constraints and expressive freedom. The medium's inherent limitations—toxicity, extended curing periods, unpredictable material properties—function not as developmental hindrances but as generative conditions cultivating unique artistic expression. Authentic modernization requires navigating between fundamentalist adherence to ossified forms and nihilistic abandonment of material essence. True transformation emerges through creative breakthrough—deconstructing traditional paradigms while remaining faithful to material ontological core.

This research contributes to contemporary art theory in several dimensions. It extends materialist philosophy into specific craft modernization contexts, demonstrating material agency theory's practical applicability. It refines medium-specificity discourse for post-medium conditions, illustrating how differential specificity operates in non-Western traditions. It develops analytical framework for understanding technical deconstruction as aesthetic strategy rather than merely procedural modification.

For practitioners, several insights emerge: technical innovation should be conceptually motivated rather than pursued for novelty; material properties can function as generative constraints rather than limitations; tradition and modernity need not be oppositional but can engage in productive dialogue; global relevance can be achieved through cultural specificity rather than despite it.

Future research should investigate comparative analysis of Japanese, Korean, and Southeast Asian lacquer modernization trajectories; reception studies examining how diverse audiences engage with contemporary works; longitudinal studies tracking emerging artists and evolving innovations; collaborative interdisciplinary research integrating materials science with art historical analysis.

Only when lacquer is no longer viewed as fossilized heritage demanding preservation, but instead recognized as living medium capable of contemporary philosophical reflection, can it achieve genuine liberation. The future lies not in nostalgic preservation nor radical rupture, but in critical, creative engagement with material traditions that honor their richness while embracing contemporary possibilities. This path requires courage to deconstruct, wisdom to discern what remains vital, and imagination to reconstruct—qualities embodied in the most compelling contemporary lacquer practices examined here.

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Ethics Statement

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Generative AI in Entrepreneurship Education: Enhancing Faculty's Instructional Design and Pedagogical Capacities

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Abstract

Generative artificial intelligence (GenAI) is reshaping entrepreneurship education by supporting faculty in instructional design and pedagogical practice. This conceptual review integrates recent literature (2022-2025) to develop a theoretical framework examining how GenAI enhances faculty capacities across instructional design (course development, case creation, activity design, assessment) and pedagogical competencies (innovative teaching, personalization, reflective practice). Drawing on the Technology Acceptance Model, AI-TPACK framework, and entrepreneurship pedagogy literature, this study reconceptualizes GenAI as a capacity development mediator rather than merely an efficiency tool. While early experimental studies suggest potential time savings, realizing these benefits requires integration with professional judgment, as quality concerns—including fabricated citations and context adaptation needs—underscore the indispensable role of faculty expertise. Four key contributions emerge: (1) a dual-dimensional framework for GenAI-mediated capacity development; (2) identification of four distinct faculty adoption profiles requiring differentiated support; (3) critical challenges spanning academic integrity, ethics, digital equity, and training deficits; and (4) evidence-based multi-level intervention recommendations. This framework has significant implications for teacher education programs and institutional policies governing AI integration in entrepreneurship education.

Keywords
Generative Artificial Intelligence; Entrepreneurship Education; Instructional Design; Pedagogical Capacity; Faculty Development

1. Introduction

The emergence of generative artificial intelligence (GenAI) marks a paradigm shift in higher education unseen since the advent of the internet (Winkler et al., 2023). ChatGPT's release in November 2022 catalyzed unprecedented attention, accumulating 100 million monthly users within two months—the fastest adoption rate in internet history (Ratten & Jones, 2023). For entrepreneurship education, this technological transformation carries particular significance: as 70% of future startups are projected to operate on digital platforms (Bell & Bell, 2023), entrepreneurship faculty face dual imperatives of preparing digitally literate entrepreneurs while enhancing their own digital pedagogical capacities.

Entrepreneurship education distinctively emphasizes experiential learning, case-based instruction, and business plan development—pedagogical approaches requiring substantial faculty time and expertise (Pita et al., 2021). High-quality instructional design demands extensive investment in content curation, case development, activity planning, and assessment creation. GenAI's potential to augment these processes has generated considerable interest, with ChatGPT becoming the most discussed technological tool among management educators (Ratten & Jones, 2023).

Despite growing research on GenAI in education, a critical gap persists: Chen et al. (2024) revealed that 65% of studies focus on student learning applications, with only 35% examining faculty professional development. This imbalance reflects insufficient scholarly attention to the fundamental question: How can entrepreneurship faculty leverage GenAI to enhance their instructional design and pedagogical capacities? This gap is particularly problematic given that teacher capabilities constitute the prerequisite for effective technology-enhanced student learning.

The present review addresses this gap through conceptual integration of recent literature (2022-2025), developing a theoretical framework for understanding how GenAI tools may transform entrepreneurship faculty capacities. Unlike existing reviews emphasizing student outcomes or technical capabilities, This review adopts a faculty-centric perspective to examine three interrelated questions: (1) How might GenAI support entrepreneurship faculty's instructional design work, and what evidence exists regarding these applications? (2) Through what theoretical mechanisms could GenAI enhance faculty pedagogical competencies? (3) What challenges complicate GenAI integration, and what strategies might address these challenges? This study approach is conceptual rather than systematic. We draw selectively on illustrative empirical studies to ground theoretical propositions, prioritizing recent high-impact publications and diverse methodological approaches (experimental studies, case analyses, conceptual frameworks) that illuminate different facets of faculty-AI interaction. This selective integration enables deeper engagement with theoretical nuances and practical complexities than comprehensive systematic reviews typically afford.

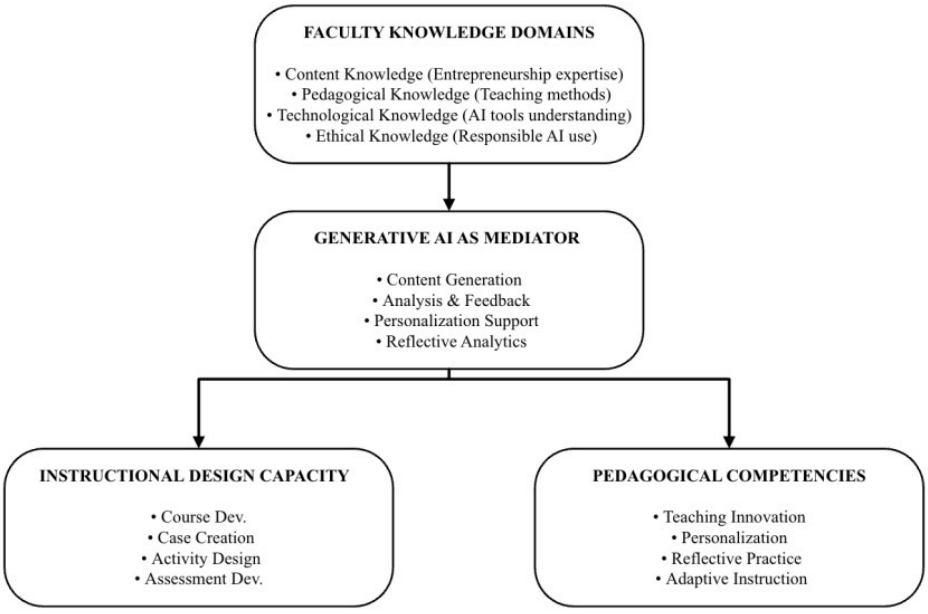

Figure 1 Conceptual framework - GenAI as mediator of faculty capacity development

Our inquiry is theoretically grounded in the AI-TPACK (Technological Pedagogical Content

Knowledge) framework (Celik, 2023; Wang et al., 2024), which posits that effective AI integration requires sophisticated interplay among technological knowledge, pedagogical expertise, content mastery, and ethical judgment. This framework conceptualizes GenAI not as a replacement for faculty expertise but as a mediating tool that, when properly integrated, can amplify instructional design capabilities and pedagogical competencies. Figure 1 presents our conceptual framework positioning GenAI as a mediator between faculty knowledge domains and enhanced teaching capacities.

This review makes three primary contributions to entrepreneurship education scholarship. Building upon the AI-TPACK framework (Celik, 2023; Wang et al., 2024), Existing theory is extended through: (1) specifying the dual-dimensional structure of faculty capacity development in entrepreneurship education contexts—distinguishing instructional design capabilities from pedagogical competencies; (2) identifying four types of augmented expertise (verification, pedagogical evaluation, prompt engineering, contextualization) required for effective GenAI integration, which current TPACK models do not adequately capture; and (3) proposing differentiated intervention strategies aligned with distinct faculty adoption profiles. Rather than claiming a wholly new framework, this study offers a domain-specific elaboration that addresses entrepreneurship education's unique pedagogical demands—particularly the tension between AI's pattern-recognition strengths and entrepreneurship's emphasis on uncertainty management and tacit knowledge.

While this review adopts a conceptual rather than systematic approach, our literature selection followed deliberate criteria to ensure theoretical coherence and empirical grounding. Searches were conducted in Web of Science, Scopus, and Google Scholar using keywords: ("generative AI" OR "ChatGPT" OR "large language model") AND ("entrepreneurship education" OR "faculty development" OR "instructional design") AND (2022-2025). From the initial pool of 287 articles, Priority was given to: (1) peer-reviewed journal articles and high-impact conference proceedings; (2) studies directly addressing faculty capabilities rather than student outcomes; (3) diverse methodological approaches (experimental, qualitative, conceptual) to triangulate insights; and (4) publications demonstrating theoretical advancement beyond descriptive accounts. This purposive sampling yielded 45 core sources, supplemented by seminal works on TPACK and technology acceptance theory. It is acknowledged that this selective approach limits generalizability but enables deeper theoretical engagement with emerging phenomena where systematic evidence remains sparse.

2. Theoretical Foundations

Effective GenAI integration in entrepreneurship education requires theoretical frameworks explaining how technology adoption translates into capacity enhancement. This framework builds upon two foundational theories: Technology Acceptance Model (TAM) explaining adoption decisions, and AI-Technological Pedagogical Content Knowledge (AI-TPACK) framework elucidating integration competencies.

2.1 Technology acceptance and faculty profiles

The Technology Acceptance Model (Davis, 1989) identifies perceived usefulness and ease of use as primary adoption determinants. Recent research extends TAM to GenAI contexts: Shata and Hartley (2025) found that perceived usefulness is the strongest predictor of faculty attitudes toward GenAI adoption, with trust and social reinforcement serving as critical mediators. This finding carries practical implications: professional development programs should

emphasize demonstrating GenAI's concrete value for specific teaching tasks rather than merely showcasing technical sophistication.

Mah and Groß (2024) revealed faculty heterogeneity in GenAI adoption through latent class analysis, identifying four distinct profiles: (1) Optimistic (33.5%) embrace AI enthusiastically, viewing it as transformative; (2) Critical (27.3%) maintain skepticism about educational value; (3) Critically-reflective (33.9%) acknowledge potential while maintaining cautious stance; (4) Neutral (5.3%) lack formed opinions. Notably, 78.5% expressed interest in AI professional development regardless of profile, suggesting recognition of skill necessity despite attitudinal differences. These profiles imply that one-size-fits-all training approaches will prove ineffective; instead, differentiated strategies addressing each profile's concerns and readiness levels are required.

2.2 AI-TPACK: Integrative framework for competency development

Traditional TPACK framework (Mishra & Koehler, 2006) posits that effective technology integration requires synthesis of Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). AI's emergence necessitates framework evolution. Celik (2023) proposed Intelligent-TPACK, incorporating AI-specific ethical knowledge as an essential fourth dimension. Empirical analysis revealed that Technological-Pedagogical Knowledge (TPK)—understanding how to deploy AI tools in specific instructional contexts—proves most critical for effective integration, with ethical evaluation capacity exhibiting comparable importance to TPK in predicting overall AI-TPACK levels.

Wang et al. (2024) further refined this framework, delineating seven interrelated AI-TPACK components: PK, CK, AI-TK, Pedagogical-Content Knowledge (PCK), AI-Technological-Content Knowledge (AI-TCK), AI-Technological-Pedagogical Knowledge (AI-TPK), and integrated AI-TPACK. Structural equation modeling demonstrated significant interactions among dimensions, with AI-TPK (understanding AI tool deployment in pedagogical contexts) contributing most substantially to overall AI-TPACK. Critically, Wang et al. (2024) found that informal self-directed learning proves insufficient for developing comprehensive AI-TPACK; systematic training is essential. This finding provides empirical justification for institutional investment in structured faculty development programs.

2.3 Entrepreneurship pedagogy considerations

Entrepreneurship education's distinctive characteristics necessitate discipline-specific theoretical considerations. Fox et al. (2024) proposed the AIEE (Artificial Intelligence in Entrepreneurship Education) framework, distinguishing five learning task phases (preparation, execution, monitoring, reflection, integration) and specifying AI's appropriate roles (leader, collaborator, supporter) in each phase. This framework helps faculty understand that AI is not a universal solution but requires strategic deployment aligned with pedagogical objectives and learning stages.

For instance, in business plan initial drafting (preparation/execution phases), AI may serve as content framework leader; however, in critical decision-making and value judgment moments (monitoring/reflection phases), human faculty must retain leadership. This nuanced understanding prevents both over-reliance on AI and unnecessary resistance to potentially beneficial applications.

Lyu et al. (2023) distinguished theory-oriented from practice-oriented entrepreneurship ped-

agogy, finding practice-oriented approaches contribute more strongly to entrepreneurial processes (from opportunity identification to venture creation), while theory-oriented pedagogy exerts greater impact on opportunity development stages. This differentiation implies that GenAI applications should vary by pedagogical approach: in practice-oriented contexts emphasizing hands-on experimentation, AI serves as real-time feedback and iterative optimization tool; in theory-focused instruction, AI provides diverse explanatory perspectives and case materials. Table 1 synthesizes key theoretical constructs and their implications for entrepreneurship faculty development.

Table 1 Theoretical foundations and faculty development implications

Theoretical Framework	Key Constructs	Core Findings	Faculty Development Implications
Technology Acceptance Model (TAM)	Perceived Usefulness, Ease of Use, Trust	Usefulness is strongest predictor; trust mediates adoption (Shata & Hartley, 2025)	Demonstrate concrete value for specific teaching tasks; build trust through transparent AI capabilities/ limitations
Faculty Profile Theory	Optimistic, Critical, Critically-reflective, Neutral	Four distinct profiles with 78.5% interested in PD (Mah & Groß, 2024)	Design differentiated training addressing each profile's concerns; avoid one-size-fits-all approaches
AI-TPACK Framework	AI-TK, PK, CK, AI-TPK, Ethical Knowledge	AI-TPK most critical; informal learning insufficient (Wang et al., 2024; Celik, 2023)	Provide systematic training integrating technology, pedagogy, content, ethics; emphasize contextual application
AIEE Framework	Five learning phases; Three AI roles (leader, collaborator, supporter)	AI role must align with learning phase and pedagogical objective (Fox et al., 2024)	Train faculty to strategically deploy AI based on task phases; avoid blanket adoption or rejection
Entrepreneurship Pedagogy Theory	Theory-oriented vs. Practice-oriented approaches	Practice-oriented pedagogy has stronger impact on venture creation (Lyu et al., 2023)	Customize AI applications to pedagogical approach; use AI differently in theory vs. practice contexts

3. GenAI Enhancement of Instructional Design Capabilities

Instructional design capability—encompassing course development, case creation, learning activity design, and assessment tool development—constitutes a core dimension of faculty professional competence. This review proposes that GenAI transforms these capacities through three interrelated theoretical mechanisms: efficiency amplification through automation of routine tasks, creative expansion through rapid prototyping and iteration, and quality mediation through the dialectic between AI generation and faculty refinement. However, each mechanism operates within constraints requiring sophisticated faculty judgment, which conceptualized as augmented expertise.

This section analyzes how these mechanisms manifest across four instructional design dimensions, drawing on illustrative empirical studies to ground theoretical propositions. This analysis argues that GenAI functions most effectively not as a replacement for faculty expertise but as a mediator amplifying capabilities when integrated with professional judgment. Figure 2 illustrates the AI-assisted course development workflow scholar propose, emphasizing critical faculty judgment checkpoints throughout the design process.

GenAI demonstrates potential for substantial efficiency gains in course development tasks. Experimental evidence provides preliminary support: Choi et al. (2024) found professional

instructional designers using ChatGPT completed course mapping 65% faster than manual approaches in controlled settings (n=24, comparative experiment). Importantly, AI-assisted designers produced more iterative versions within equivalent timeframes, enabling enhanced refinement opportunities—suggesting efficiency gains may translate to quality improvements when faculty reinvest saved time in revision cycles.

However, this efficiency dividend accompanies significant quality risks that necessitate expert oversight. The same Choi et al. (2024) study identified that 40% of AI-generated content contained fabricated citations—"hallucinations" presenting fictitious references as authentic. This finding underscores a critical principle: GenAI outputs must be treated as drafts requiring expert validation rather than finished products. Domain expertise in content verification remains irreplaceable, highlighting the first dimension of augmented expertise: verification capacity.

GenAI supports multiple course development tasks, each requiring specific faculty competencies. For learning objective brainstorming, Luo et al.'s (2024) study found instructional designers using GenAI-assisted brainstorming achieved 47% greater idea diversity measured through semantic analysis. However, translating quantity to quality requires faculty applying pedagogical frameworks like Bloom's Taxonomy to select and refine objectives ensuring appropriate cognitive levels and measurability. This exemplifies the second dimension of augmented expertise: pedagogical evaluation capacity.

For module outlines and content frameworks, Ruiz-Rojas et al. (2023) demonstrated that structured instructional design frameworks significantly improve AI output quality. The 4PADAFE matrix integrating Pedagogical objectives, Activities, Assessment, Digital resources, Feedback, and Evaluation guides AI generation toward systematically coherent outputs aligned with instructional design principles. Compared to simple open-ended prompts such as "help me design an entrepreneurship course," structured prompting yields more comprehensive, pedagogically sound content. This illustrates the third dimension of augmented expertise: prompt engineering capacity grounded in instructional design knowledge.

Nevertheless, Hu et al. (2024) found that 78% of GPT-4 generated lesson plans required substantial adaptation to local standards and learner contexts when implemented by 156 teachers in authentic classrooms, indicating AI outputs demand expert review and localization rather than direct implementation. This adaptation necessity reflects AI's training on predominantly Western, English-language data, requiring faculty to apply cultural competence and contextual knowledge in customization—the fourth dimension of augmented expertise: contextualization capacity.

Figure 2 illustrates our proposed workflow integrating AI capabilities with faculty judgment at critical checkpoints. The workflow operates in three stages, each with distinct faculty responsibilities. In Stage 1, faculty provide course topics, learning outcomes, and constraints as input. AI then generates draft objectives and outlines. At Faculty Judgment Checkpoint 1, educators evaluate outputs by determining whether cognitive levels are appropriate through applying Bloom's Taxonomy, verifying alignment with intended outcomes, checking content accuracy including facts and citations, and detecting fabricated references. In Stage 2, faculty provide revision prompts specifying local context, cultural adaptation needs, and specific examples. AI regenerates content incorporating faculty guidance. At Faculty Judgment Checkpoint 2, quality is assessed through examining cultural appropriateness for target student populations, local relevance to institutional standards and regional contexts, and alignment with student prerequisites. In Stage 3, faculty synthesize their professional expertise, pedagogical

judgment, contextual knowledge, and ethical considerations to produce the final implementation-ready course design.

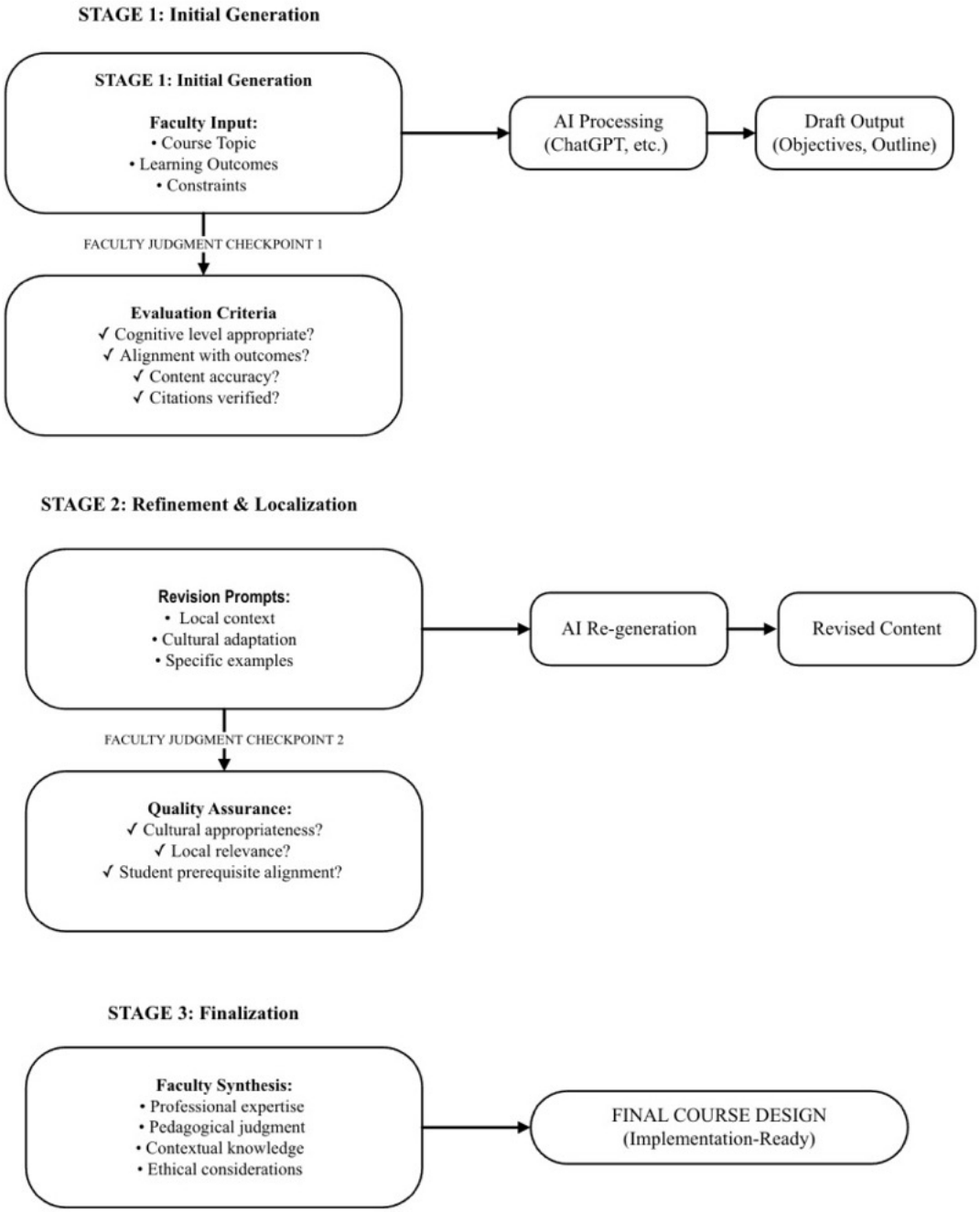

Figure 2 AI-assisted course development workflow

This workflow embodies our central theoretical argument: effective AI integration requires active faculty mediation at each stage rather than passive acceptance of AI outputs. The checkpoints represent moments where augmented expertise proves indispensable.

Case-based pedagogy represents a cornerstone of entrepreneurship education, yet high-quality case development has historically been time-intensive, requiring extensive primary data collection and narrative crafting. GenAI offers innovative solutions for rapid case generation while raising authenticity questions that require careful theoretical and practical consideration. Short and Short (2023) demonstrated ChatGPT's ability to emulate prominent entrepreneurs' communication styles, successfully generating content mimicking Elon Musk, Indra Nooyi,

Tony Hsieh, and Lisa Su. Expert review validated stylistic similarity, revealing GenAI's potential for creating diverse entrepreneurial communication cases, investor pitch simulations, and business negotiation dialogues.

However, researchers cautioned that AI-generated content, while stylistically accurate, may lack authentic contextual nuances and non-verbal elements characterizing real situations. This distinction between stylistic emulation and substantive authenticity represents a critical theoretical insight: AI excels at pattern reproduction but struggles with contextual depth and tacit knowledge embedded in authentic cases. Consequently, such materials better serve introductory practice exercises rather than replacing in-depth authentic case analysis requiring students to grapple with genuine complexity and ambiguity.

George-Reyes et al. (2024) provided methodological guidance through quasi-experimental research integrating ChatGPT into scientific entrepreneurship education via the i4C method: Identify, Conceive, Invent, and Communicate. Among 105 Ecuadorian graduate students, significant improvements in scientific entrepreneurship knowledge acquisition were achieved, with pre-post test differences statistically significant at $p<0.001$. This study demonstrated that AI not only assists narrative script creation but supports real-time feedback and iterative optimization in business plan development—embodying our theoretical mechanism of creative expansion through rapid iteration. Faculty can adapt this framework to develop narratively engaging entrepreneurship scenario cases by providing AI with industry background, venture challenges, and key stakeholder information to generate initial case narratives, then applying pedagogical expertise to refine plot structure, conflict points, and decision dilemmas.

Darnell et al. (2024) emphasized practical application, providing reusable teaching activity templates such as using large language models to create pros-cons analyses of Lean Startup versus Design Thinking methodologies. For entrepreneurship faculty, this means rapidly generating case materials reflecting current market dynamics and industry trends, overcoming traditional case repositories' update lags. When emerging technologies such as Web3, blockchain, or sustainable energy spark entrepreneurial waves, faculty can immediately generate relevant cases rather than awaiting formal publication.

However, effective case creation using AI requires what this review terms authenticity judgment capacity—the ability to distinguish between surface-level plausibility and genuine authenticity, to identify where AI-generated scenarios oversimplify complex stakeholder dynamics, and to recognize when fabricated elements undermine pedagogical value. This represents a sophisticated expertise dimension potentially more demanding than creating cases manually, as faculty must simultaneously evaluate AI output quality while envisioning how students will engage with materials.

Business simulations and design thinking exercises constitute popular entrepreneurship teaching activities. Silitonga et al. (2024) confirmed through quasi-experimental research that business simulation games significantly enhance students' cognitive and non-cognitive entrepreneurial competencies, with Cohen's d effect sizes ranging 0.62-0.85 representing medium to large effects, and strengthen entrepreneurial intentions. GenAI can enhance simulation adaptivity and personalization in ways traditional systems cannot. Traditional simulation systems operate on preset rules and parameters, presenting identical scenarios to all students. AI-driven simulations can dynamically adjust difficulty levels and contextual parameters based on students' decision history, performance, and learning styles—embodying our theoretical mechanism of personalization scaling.

Faculty might design AI-powered virtual mentor systems providing differentiated hints and challenges during simulations: introducing more complex market changes or competitive threats for advanced students, offering more guided prompts and resources for struggling students. This adaptive scaffolding can address a persistent challenge in entrepreneurship education: accommodating heterogeneous student populations with varying prior business knowledge, risk tolerance, and entrepreneurial experience.

However, Krushinskaia et al. (2024) warned of significant risks. Their study found that 40% of instructional designers accepted AI suggestions without sufficient adjustment, resulting in decreased course creativity. This finding indicates faculty must maintain critical thinking when using AI for activity enhancement, ensuring AI intervention genuinely serves pedagogical goals rather than oversimplifying learning complexity. The theoretical insight here involves what this review terms the complexity preservation imperative: GenAI's tendency toward pattern-based solutions may inadvertently reduce the productive struggle and ambiguity that characterize effective entrepreneurship education. Faculty augmented expertise must include capacity to recognize when AI suggestions, while technically competent, pedagogically undermine learning objectives by removing necessary complexity.

For Design Thinking—another core entrepreneurship methodology—GenAI supports multiple stages: analyzing user interview data to identify key pain points during empathy phase; assisting problem statement refinement for focus and feasibility during definition phase; generating numerous creative solutions to stimulate divergent thinking during ideation phase; producing initial concept sketches or interface prototypes during prototyping phase. Wannamakok et al. (2023) confirmed that Design Thinking-based online learning effectively enhances entrepreneurial intention, with peer interaction and guest sharing significantly impacting outcomes. GenAI can augment these processes without replacing the fundamentally social and collaborative nature of effective Design Thinking pedagogy—provided faculty maintain focus on human interaction as central rather than peripheral to learning.

Assessment design constitutes among faculty work's most challenging aspects, requiring balance among validity, reliability, fairness, and feasibility. GenAI demonstrates significant efficiency potential while raising assessment authenticity concerns that require careful theoretical analysis. Cheng et al. (2024) developed the TreeQuestion system illustrating AI breakthroughs in objective item generation. Utilizing large language models for automatic multiple-choice question generation, the system reduced generation time by 95%, achieving 300% assessment volume increase without compromising rigor. Employing "knowledge tree" architecture ensures generated items cover all course content knowledge points, with automatic distractor quality analysis maintaining item quality.

Research demonstrated effective conceptual learning outcome assessment capability, though limitations persist in evaluating higher-order cognitive abilities like creative thinking—a critical concern for entrepreneurship education emphasizing innovation, opportunity recognition, and adaptive problem-solving. Researchers emphasized that expert oversight remains indispensable for ensuring cognitive objective alignment—faculty must review whether AI-generated items genuinely measure intended outcomes and contain no ambiguities or cultural biases.

Chiu et al. (2024) conducted a scoping review on how GenAI transforms higher education assessment, arguing assessment must transform to cultivate students' self-regulated learning skills, with responsible learning and academic integrity as core concerns. They recommended

integrating assessment redesign with AI literacy training in faculty professional development, while strengthening faculty belief clarification regarding human versus AI assessment roles. For entrepreneurship faculty, this necessitates reconceptualizing core assessment tasks like business plan evaluation, entrepreneurial pitch scoring, and reflection report review. Rather than asking "How can AI grade this assignment?", the more productive question becomes "How should we redesign assessments to measure capabilities AI cannot replicate?"—focusing on higher-order thinking, authentic performance, and situated judgment that require human evaluation.

This leads to what Chiu et al. (2024) termed "AI-resistant assessment" concepts, emphasizing assessment should measure higher-order cognitive abilities and authentic context performance. Specific strategies include increasing process assessment weight by requiring students to document thinking journals and decision processes, which AI cannot forge authentically; designing tasks based on authentic enterprise engagement requiring first-hand data from interviews or field research that AI cannot generate; adopting oral defense formats examining students' deep understanding of and critical reflection on their work through dialogic reasoning AI cannot replicate; and designing complex synthesis tasks requiring integration of multiple information sources across modalities where AI limitations persist in multi-modal, cross-contextual integration.

Effective assessment development using AI requires what this review terms construct validity preservation capacity—ensuring that efficiency gains from AI-generated items do not come at the cost of measuring what we intend to measure. Faculty must develop sophisticated ability to evaluate whether AI-generated assessments genuinely capture entrepreneurial competencies such as opportunity recognition, effectual reasoning, resource mobilization, and tolerance for ambiguity versus merely testing factual recall or surface-level comprehension.

Table 2 GenAI applications in instructional design: efficiency, quality, and faculty judgment

Design Dimension	GenAI Application	Efficiency Gains	Quality Concerns	Needed Faculty Expertise
Course Development	Learning objectives; Outlines; Module design	Faster design; Higher idea diversity	Fabricated citations; Western bias; Requires major classroom adaptation	Error checking; Pedagogical alignment; Local contextualization
Case Creation	Scenario writing; Stakeholder dialogue	Rapid case generation; Supports iterative planning	Lacks contextual nuance; Stereotypes; Oversimplifies complexity	Authenticity judgment; Cultural competence; Narrative design
Activity Design	Simulation personalization; Design Thinking scaffolds; Adaptive difficulty	Personalized learning paths; Improved competency outcomes	Overreliance on AI suggestions; Reduced creativity; Oversimplified struggle	Maintain cognitive complexity; Ensure alignment with learning goals
Assessment Development	MCQ generation; Rubrics; Distractors	Major time savings; High item volume	Weak on higher-order skills; Limited authenticity; Cultural/language biases	Validate constructs; Calibrate cognitive levels; Detect bias

Table 2 synthesizes GenAI applications across instructional design dimensions, specifying efficiency gains reported in experimental studies, quality considerations documented across research, and required faculty judgment capacities constituting augmented expertise. Critically, this table illustrates this study central theoretical argument: GenAI enhances faculty instruc-

tional design capabilities not by replacing expertise but by requiring new forms of sophisticated judgment mediating between AI capabilities and instructional quality.

Across all four instructional design dimensions, a consistent pattern emerges: AI outputs function most effectively as starting points requiring expert refinement rather than finished products. The faculty role shifts from pure content creation to a more complex responsibility encompassing content generation facilitation, critical evaluation, context-specific adaptation, and quality assurance. This shift arguably requires higher-level capabilities than traditional instructional design, as faculty must simultaneously understand AI capabilities and limitations, maintain pedagogical vision, apply domain expertise, and exercise ethical judgment—embodying augmented expertise as integration of technological, pedagogical, content, and ethical knowledge dimensions consistent with AI-TPACK framework (Celik, 2023; Wang et al., 2024).

4. GenAI Enhancement of Pedagogical Competencies

Beyond instructional design efficiency, GenAI fundamentally enhances faculty pedagogical competencies—teaching innovation capacity, personalization capability, and reflective practice—transforming how faculty conceptualize and enact their professional roles.

4.1 Teaching innovation capacity: expanding pedagogical possibilities

Teaching innovation capacity reflects faculty ability to continuously improve methods, develop novel activities, and integrate frontier knowledge. Bell and Bell (2023) noted that AI tools enable faculty to rapidly acquire and integrate cross-domain knowledge, overcoming individual experience limitations. For many entrepreneurship faculty whose professional backgrounds may be confined to specific industries or functional areas, yet entrepreneurship education demands multi-faceted knowledge spanning technology, markets, finance, and operations, AI serves as a "knowledge bridge" facilitating rapid familiarization with unfamiliar domains' foundational knowledge.

Lim et al. (2023) employed paradox theory to reconcile educational tensions surrounding GenAI, proposing a framework positioning AI as transformative resource coexisting with educators. This theoretical perspective helps faculty transcend binary thinking (complete embrace versus complete resistance), exploring organic integration models combining AI with traditional teaching methods.

Neergård and Roald (2025) revealed that many faculty position themselves as "entrepreneurship outsiders," perceiving themselves as lacking entrepreneurship teaching capability. GenAI tools can help such faculty bridge knowledge gaps by accessing entrepreneurship cases, industry trends, and teaching resources. However, Ding et al. (2024) demonstrated that case-based AI professional development proves more effective than abstract technical training, with ill-structured problems promoting superior knowledge application, though model cases should precede ill-structured problem-solving.

4.2 Personalization capacity: scaling individualized instruction

Personalized instruction represents a core educational technology goal. Ali et al. (2025) systematically reviewed confirming AI significantly optimizes educational outcomes through customized content and feedback, with adaptive learning systems enhancing student engagement. For entrepreneurship faculty, this enables differentiated learning paths based on students' en-

trepreneurial interest domains, learning styles, and competency levels.

Chen et al. (2024) identified four primary AI application domains: personalized and adaptive instruction, simulation-based entrepreneurship training, ethical and psychological concerns, and ecosystem integration through intelligent systems, providing a clear roadmap for developing personalization capacity. Faculty can utilize AI to analyze students' business plan drafts for targeted improvement suggestions; generate customized case materials based on students' industry interests; design modular content adapting to different learning paces.

However, achieving genuinely effective personalized instruction requires faculty to possess four critical competencies: (1) Data literacy—interpreting AI-provided learning analytics data to identify authentic needs beyond surface characteristics; (2) Pedagogical knowledge—understanding different personalization strategies' (content differentiation, process differentiation, product differentiation) appropriate contexts; (3) Technical integration capability—configuring and adjusting AI system parameters for outputs aligned with pedagogical objectives; (4) Humanistic care—recognizing that not all student needs can be met through technological means, with certain situations requiring irreplaceable face-to-face teacher-student interaction.

Mulaudzi and Hamilton (2025) explored AI's role in personalized learning from teacher perspective, finding attitudes ranging from skepticism to cautious optimism, with initially negative attitudes often transforming into recognition of AI brainstorming utility following direct value experience. This finding carries important implications for training programs: progressive exposure and guided practice should help faculty overcome initial concerns while sharing appropriate AI integration success cases.

4.3 Reflective practice capacity: evidence-based professional growth

Reflective practice constitutes a core dimension of teacher professional development. Yik et al. (2023) distinguished three reflection levels: surface reflection (descriptive event recording), pedagogical reflection (analyzing relationships between teaching strategies and learning outcomes), and critical reflection (examining one's teaching beliefs and values). Research demonstrated that technology-driven methods (video analysis, blog writing, online discussion) can support reflection activities across levels, with GenAI providing novel reflection tools—faculty can use AI to analyze teaching video transcript texts, obtaining insights regarding questioning strategies, feedback patterns, and classroom interaction.

Li and Walsh (2023) demonstrated how Video-Enhanced Observation (VEO) supports dialogic reflection, proving reflective practice develops progressively over time with evidence-based reflection playing crucial roles in cognitive and practice development. GenAI can enhance this process: through natural language processing analysis of classroom dialogue, AI can identify teachers' question type distributions (closed versus open questions), wait time patterns, differential attention across students. These quantitative data provide faculty a "mirror" for reflection, helping discover previously unrecognized teaching patterns.

Mai et al. (2024) employed Biggs' Presage-Process-Product (3P) model to systematically review ChatGPT applications, identifying 13 advantages and 10 disadvantages. This structured analytical framework can be applied by faculty for reflecting on their own AI integration practices—reflecting on how AI assists course material development in presage stage, how AI supports personalized instruction in process stage, how AI affects learning outcomes and academic integrity in product stage.

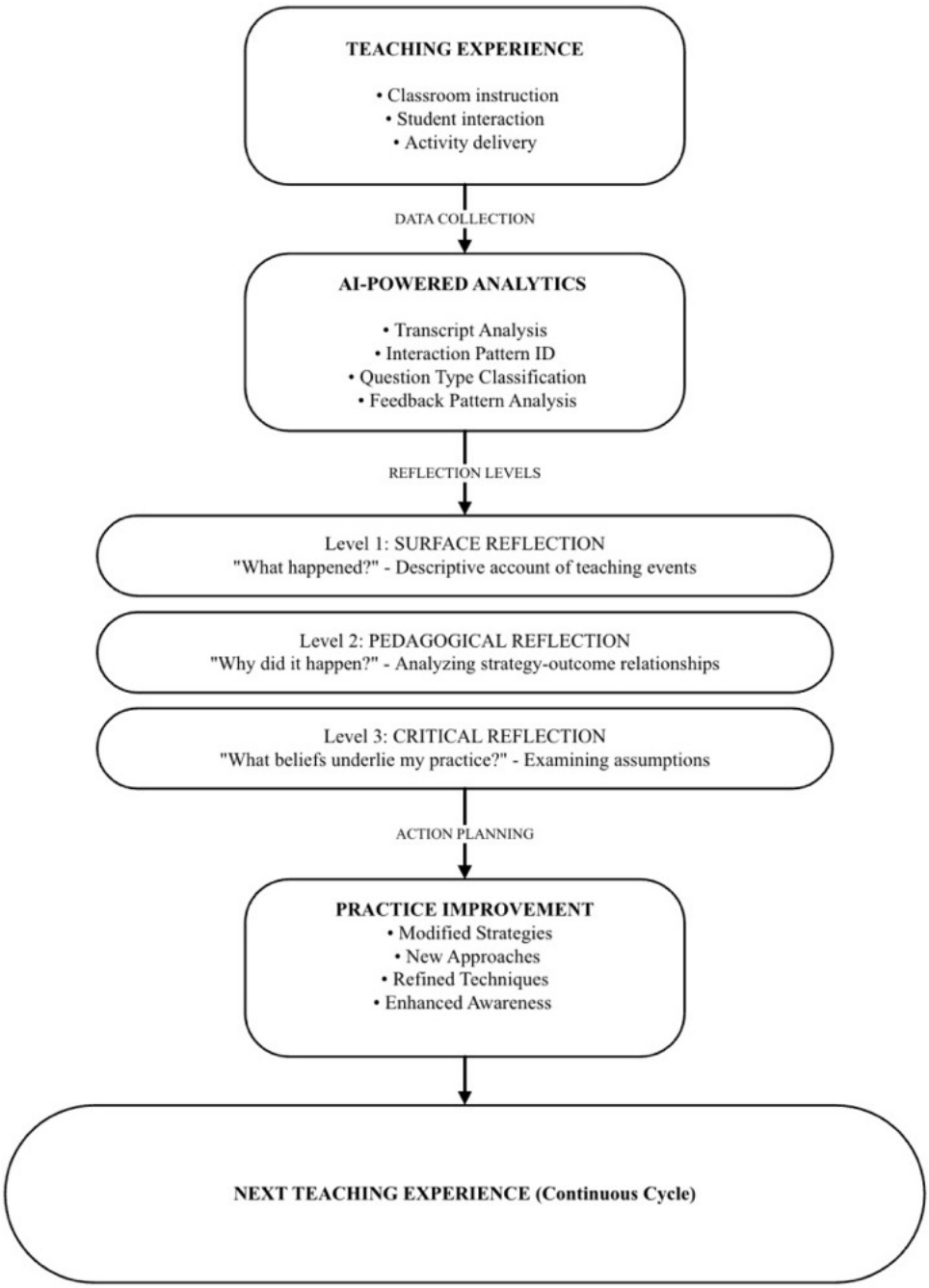

Figure 3 GenAI-enhanced reflective practice cycle for faculty development

5. Challenges and Strategic Responses

Despite GenAI's transformative potential, entrepreneurship faculty encounter multiple challenges in integration, spanning academic integrity concerns, ethical considerations, digital inequities, and professional development deficits. Addressing these challenges requires coordinated efforts across policy, institutional, and individual levels.

5.1 Academic integrity and assessment authenticity

When students can readily use AI to generate business plans and case analyses, traditional assessment methods face fundamental validity challenges. Ratten and Jones (2023) emphasized ChatGPT's transformative capability in changing assessment implementation and grading, necessitating urgent policies regarding ChatGPT and subsequent GenAI. However, policy for-

mulation faces dilemmas: complete AI prohibition proves both unrealistic (difficult to monitor effectively) and unreasonable (depriving students of learning future professional tools); complete permission may foster over-reliance, hindering authentic capability development.

More viable strategies involve assessment task redesign rendering them less amenable to complete AI replacement. Chiu et al. (2024) proposed "AI-resistant assessment" concepts, emphasizing assessment should measure higher-order cognitive abilities and authentic context performance. Specific strategies include: increasing process assessment weight, requiring students to document thinking journals and decision processes (AI cannot forge cognitive processes); designing tasks based on authentic enterprise interviews or field research, requiring first-hand data submission (AI cannot generate original field data); adopting oral defense formats examining students' deep understanding of and critical reflection on AI-generated content; designing complex tasks requiring synthesis of multiple information sources (AI limitations persist in multi-modal, cross-contextual information integration).

5.2 Ethical considerations and digital equity

Ethical considerations permeate AI teaching applications. Celik (2023) demonstrated ethical evaluation capability constitutes an indispensable component of teachers' AI integration knowledge. Hodges and Kirschner (2024) warned that AI-driven systems, without careful monitoring, may amplify existing inequalities. Bolick and da Silva (2024) found 28% of AI image outputs perpetuated stereotypes, such as over-representing white males when generating "successful entrepreneur" images.

Digital divides constitute another ethical challenge. Though GenAI tools claim universal accessibility, actual usage effectiveness depends heavily on users' digital literacy, English proficiency, and high-quality network access. Acosta-Enriquez et al. (2024) found knowledge deficiency and distrust constitute primary AI adoption obstacles. For students from educationally under-resourced backgrounds, they may lack prerequisite knowledge and skills for effective AI tool use, placing them at greater disadvantage in AI-enhanced teaching environments. Faculty must recognize this digital inequality and adopt measures narrowing gaps, such as providing AI tool usage foundational training, designing alternative learning paths not entirely dependent on AI, ensuring assessment standards are fair to all students.

5.3 Faculty training deficits and professional development needs

Current most severe challenge is critically insufficient faculty training. Chen et al. (2024) revealed research imbalance—only 35% of studies explore AI for teacher professional development, reflecting policymakers' and educational institutions' insufficient attention to teacher-side needs. Many faculty are thrust to "AI integration" frontlines without adequate training, facing technical operation challenges, managing student AI usage pedagogical issues, and contemplating AI's deep pedagogical implications.

Mah and Groß (2024) found 78.5% of faculty expressed interest in AI teaching professional development, yet existing training programs manifest three problems: (1) overemphasizing technical operations (how to use) while neglecting pedagogical integration (how to teach with) and critical reflection (when and why to use); (2) adopting "one-size-fits-all" training models failing to accommodate different disciplines' and teaching contexts' differential needs; (3) lacking continuity support, with faculty lacking ongoing practice, feedback, and improvement mechanisms after initial training.

Future faculty professional development programs should adopt these strategies: First, employ differentiated training models, providing customized support based on faculty AI familiarity, disciplinary backgrounds, and teaching contexts. Ding et al. (2024) demonstrated case-based AI professional development proves more effective than abstract technical training because cases exhibit concrete situations and decision processes for AI integration. Second, establish "community of practice" mechanisms supporting peer learning and experience sharing among faculty. Yang and Stefaniak (2025) revealed faculty attitudes became more positive and usage strategies more mature following AI integration experience exchanges with colleagues. Third, provide continuous technical and pedagogical support rather than one-off workshops. Kumar et al. (2024) noted instructional designers play critical bridging roles in faculty AI integration processes, yet many institutions lack such professionals, leaving faculty without assistance channels when encountering problems. Figure 4 presents a comprehensive framework for addressing GenAI integration challenges through multi-level strategies.

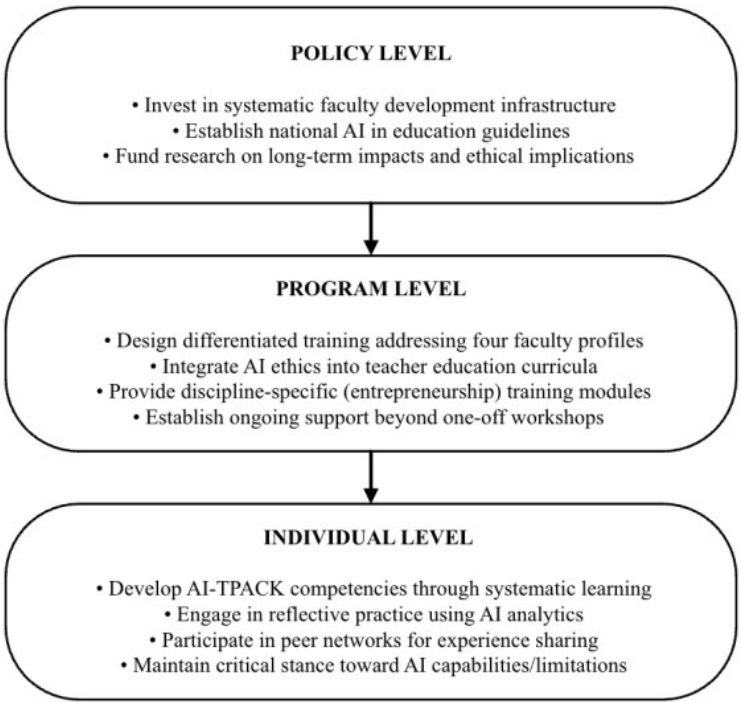

Figure 4 Multi-level strategies for addressing GenAI integration challenges

6. Discussion

This review's primary theoretical contribution lies in systematically articulating GenAI's paradigm shift from "teaching tool" to "capacity development mediator." Traditional educational technology research typically focuses on technology features' direct impacts on learning outcomes (Chiu et al., 2024), whereas this review reveals a more complex process: GenAI tools, through restructuring faculty workflows, cognitive processes, and professional practices, indirectly foster systematic enhancement of instructional design capabilities and pedagogical competencies.

The AI-TPACK framework evolution (Celik, 2023; Wang et al., 2024) provides theoretical foundations for understanding this process, yet this review further indicates that entrepreneurship education field's AI integration exhibits distinctiveness. Entrepreneurship teaching emphasizes uncertainty management, opportunity identification, and action orientation (Fox et al., 2024), creating tension with AI tools' strengths in pattern recognition and structured task

processing. Consequently, entrepreneurship faculty AI capacity development cannot simply adopt generic educational technology frameworks but requires establishing discipline-specific theoretical models. This study proposed "instructional design capacity-pedagogical competencies" dual-dimensional analytical framework represents an initial response to this theoretical gap.

Moreover, this study analysis challenges the common assumption that efficiency gains automatically translate to quality improvements. While GenAI reduces course planning time by 65% and assessment generation by 95%, 78% of outputs require substantial adaptation (Hu et al., 2024) and 40% accept AI suggestions without adjustment leads to decreased creativity (Krushinskaia et al., 2024). These findings underscore that efficiency must be coupled with enhanced professional judgment—a sophisticated capacity requiring intentional development through systematic training and reflective practice.

This study identification of four distinct faculty profiles (Mah & Groß, 2024)—optimistic, critical, critically-reflective, neutral—carries profound practical implications. The finding that 78.5% express professional development interest despite attitudinal differences suggests that resistance often stems from insufficient understanding or concerns about pedagogical fit rather than fundamental opposition to technology. This insight shifts the professional development challenge from "convincing skeptics" to "addressing heterogeneous needs."

For optimistic faculty, advanced application training exploring innovative integration models proves most valuable. For critical faculty, case-based workshops demonstrating concrete educational value and addressing specific concerns (e.g., academic integrity, student dependency) may prove persuasive. For critically-reflective faculty, peer learning platforms facilitating experience exchange and rational discourse support their balanced perspective. This differentiated approach aligns with adult learning theory principles emphasizing relevance, autonomy, and experiential foundations.

The emphasis on reflective practice (Yik et al., 2023; Li & Walsh, 2023) as central to AI-era faculty development represents another key practical contribution. AI tools can provide teaching practice "data mirrors," but translating data into insights and insights into action improvements requires active faculty reflection and professional judgment. Professional development programs should integrate technical training with reflective practice workshops, helping faculty establish "use AI-analyze data-reflect and improve" continuous development cycles.

This conceptual literature review approach affords advantages in systematically surveying research landscapes yet manifests clear limitations. First, existing literature predominantly comprises conceptual discussions or short-term intervention studies, lacking longitudinal research tracking faculty AI capacity development trajectories. Future research should employ mixed-methods designs combining quantitative tracking (e.g., periodic AI-TPACK scale measurements) with qualitative depth description (e.g., in-depth interviews revealing teacher experiences), unveiling capacity development dynamic processes and critical turning points.

Second, reviewed studies derive primarily from high-income Western countries, with extremely scarce research on developing countries and non-English nations. AI tool accessibility, educational cultural differences, and digital infrastructure may significantly influence AI integration effects and challenges. Chen et al. (2024) similarly identified this research gap. Future research should strengthen cross-cultural, cross-contextual comparative research, exploring GenAI-enabled teaching's universal principles and localization strategies.

Third, current research predominantly focuses on individual faculty capacity development while neglecting organizational and institutional level influencing factors. Kumar et al. (2024) noted instructional designers' bridging roles in AI integration, yet many institutions lack such professional support. Future research should examine faculty AI capacity development from ecosystem perspectives, analyzing multi-level factor interactions including institutional policies, technical support, peer networks, and disciplinary cultures.

Fourth, this study review acknowledges citation limitations. While this study prioritized peer-reviewed sources, some citations reflect secondary rather than primary sources due to access constraints, and publication lag means cutting-edge 2025 developments may be underrepresented. Future systematic reviews should employ comprehensive database searches with explicit inclusion/exclusion criteria and quality appraisal protocols.

A critical yet frequently overlooked issue this review reveals: GenAI-enabled teaching's ethical dimensions should not merely be viewed as "risks requiring avoidance" but must become core components of faculty professional capacity. Celik (2023) incorporated ethical evaluation capability into Intelligent-TPACK framework, yet current teacher training often marginalizes ethical issues to "precaution checklists."

Authentic ethical capacity development requires faculty to identify three ethical problem levels: technical level (e.g., AI hallucinations, data privacy), pedagogical level (e.g., assessment fairness, academic integrity), and societal level (e.g., algorithmic bias, digital divide). Bolick and da Silva (2024) found 28% of AI image outputs perpetuate stereotypes; Hodges and Kirschner (2024) warned AI may amplify inequalities. These findings remind us that entrepreneurship education faculty, as future business leaders' cultivators, bear responsibility for helping students establish technological ethical consciousness and social responsibility awareness.

This requires teacher training to not only transmit technical operation skills but cultivate "critical technology consciousness"—understanding technology as non-neutral tools embedded with power relations and value orientations constituting social products. Entrepreneurship faculty should guide students thinking: In AI-driven entrepreneurial practice, how to balance efficiency with equity, innovation with responsibility, commercial value with social value?

Looking forward, GenAI's role in entrepreneurship education will evolve from "auxiliary tool" to "collaborative partner." Fox et al. (2024) proposed AIEE framework presaging this trend: relationships among AI, faculty, and students will become more dynamic with increasingly blurred role boundaries. This necessitates reconsidering entrepreneurship education's essential objectives.

Bell and Bell (2023) distinguished three entrepreneurship education paradigms: teaching about entrepreneurship (knowledge transmission), teaching for entrepreneurship (capability cultivation), and teaching through entrepreneurship (experiential learning). AI tools impact the first paradigm most (because knowledge transmission is readily automated), yet in latter two paradigms, AI may conversely become powerful tools for reinforcing experiential learning and cultivating entrepreneurial thinking. Future entrepreneurship education may manifest "human-AI co-creation" forms: faculty design authentic entrepreneurial challenges, AI provides real-time data and feedback, students learn decision-making and action in dynamic contexts.

However, realizing this vision requires overcoming current systemic obstacles. Policymakers need to invest in teacher professional development infrastructure rather than merely demanding faculty "embrace AI." Educational institutions need to establish cultures supporting

innovation and error tolerance, allowing faculty to experiment and learn in AI integration. Technology developers need to deeply collaborate with educators, developing tools genuinely serving pedagogical objectives rather than pursuing technological showmanship. Researchers need to continuously track AI's long-term impacts on faculty capabilities, student learning, and entrepreneurial ecosystems, providing evidence-based foundations for policymaking and practice.

7. Critical Reflection

While this review identifies GenAI's potential benefits, we must critically examine potential hidden costs that current enthusiasm may obscure.

First, the efficiency narrative risks de-skilling faculty over time. If instructors increasingly rely on AI for course design, their tacit design knowledge—developed through years of iterative refinement—may atrophy. Carr's (2014) "automation paradox" warns that as systems become more automated, operators' skills deteriorate precisely when expert intervention is most needed during system failures. For entrepreneurship faculty, this could manifest as diminished ability to create compelling cases or design activities when AI tools are unavailable or inappropriate.

Second, AI integration may amplify existing inequalities between well-resourced and under-resourced institutions. Effective GenAI use requires not just technology access but significant professional development infrastructure, instructional design support, and time for experimentation—resources disproportionately available at elite universities. This could widen quality gaps in entrepreneurship education rather than democratizing access to high-quality pedagogical resources.

Third, the emphasis on AI-assisted efficiency may inadvertently shift faculty attention from relational dimensions of teaching—mentor-student bonds, empathetic guidance through entrepreneurial setbacks, embodied modeling of entrepreneurial identity—toward optimizing content delivery. Entrepreneurship education's transformative power often derives from affective and relational elements that resist quantification or automation (Neck & Corbett, 2018).

Fourth, widespread AI adoption may produce pedagogical homogenization. If faculty globally use similar AI tools trained on similar datasets, entrepreneurship education may lose valuable diversity in pedagogical approaches, cultural perspectives, and local contextualization that currently enriches the field.

These concerns do not invalidate GenAI's potential value but underscore that integration decisions involve value trade-offs rather than purely technical optimizations. Future research must track these potential negative consequences alongside efficiency gains.

8. Conclusion

Generative artificial intelligence presents entrepreneurship education faculty with both unprecedented opportunities and significant challenges. This review developed a conceptual framework positioning GenAI not as a simple efficiency tool but as a mediator of faculty capacity development, operating through three mechanisms: efficiency amplification, creative expansion, and quality mediation. However, each mechanism's success depends fundamentally on faculty augmented expertise—the sophisticated integration of domain knowledge, pedagogical judgment, and AI literacy. This study analysis yields a central theoretical insight: effective AI

integration paradoxically requires higher-level skills than AI replacement might suggest, potentially widening rather than narrowing faculty capability gaps. This challenges assumptions underlying many institutional AI adoption initiatives and underscores the need for substantial, sustained investment in faculty professional development. Moving forward, entrepreneurship education must navigate tensions between AI's potential and its limitations, between efficiency gains and quality preservation, between standardization pressures and contextualization requirements. Success requires not passive technology acceptance but active shaping of technology-pedagogy relationships, ensuring AI genuinely serves the fundamental objective of cultivating future entrepreneurs with innovative thinking, social responsibility, and critical consciousness. The path forward demands multi-stakeholder coordination: policymakers investing in faculty development infrastructure, institutions establishing supportive cultures for experimentation, technology developers collaborating deeply with educators, and researchers tracking long-term impacts. Only through such coordinated efforts can entrepreneurship education harness AI's transformative potential while mitigating its risks.

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Ethics Statement

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