Synergistic Effects of Entrepreneurship Curriculum, Practice, and Career Integration on Educational Outcomes

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Abstract

This study examines how entrepreneurship education curriculum, entrepreneurship practice, and the integration of specialization and entrepreneurship jointly influence educational performance in a digital learning context. Drawing on entrepreneurship education and technology-mediated learning perspectives, digital technology use is proposed as a central mediating mechanism. Survey data were collected from 503 undergraduate students enrolled in entrepreneurship education courses, and structural equation modeling was employed to test the proposed relationships. The results show that entrepreneurship education curriculum and entrepreneurship practice have significant direct effects on educational performance. Digital technology use also demonstrates a strong positive effect on performance and mediates the relationships between curriculum, practice, integration, and educational outcomes. In contrast, the integration of specialization and entrepreneurship does not directly affect performance but significantly moderates the relationship between entrepreneurship practice and digital technology use, strengthening the impact of practice-based learning in career-relevant contexts. These findings indicate that entrepreneurship education outcomes emerge through the interaction of curriculum design, experiential practice, and contextual integration, with digital technology use serving as a key behavioral pathway. This study provides theoretical insight into entrepreneurship education mechanisms and practical guidance for developing digitally supported, practice-oriented, and career-aligned programs in higher education.

Keywords: Entrepreneurship Education, Digital Technology Use, Integration of Specialization And Entrepreneurship, Synergistic Effect

Introduction

Rapid digital transformation and changing employment structures have reshaped the objectives of entrepreneurship education in higher education. Universities are increasingly expected to move beyond knowledge transmission and cultivate students' practical competencies, digital skills, and career readiness. Consequently, entrepreneurship education has shifted from classroom-based instruction toward integrated approaches that combine

curriculum design, experiential practice, and career-oriented learning pathways (Quintáns Graa et al., 2024; Blackham et al., 2021; Moraes et al., 2025).

Existing studies have often examined curriculum design, practical training, and industry–education collaboration as separate components. Evidence indicates that well-designed entrepreneurship curricula can strengthen entrepreneurial knowledge and intentions, while practice-based activities such as simulations, projects, and internships support skill development and experiential learning. Research on the integration of specialization and entrepreneurship likewise emphasizes aligning disciplinary knowledge with entrepreneurial competencies to enhance employability outcomes. However, these strands remain fragmented and provide limited explanation of how these elements interact as an integrated system.

More critically, the mechanisms through which curriculum, practice, and career integration jointly influence educational outcomes remain underexplored. In particular, students' digital technology use may function as a key process connecting educational inputs to performance outcomes. In the digital era, entrepreneurship learning increasingly depends on technology-mediated activities such as online collaboration, digital business tools, and simulated entrepreneurial environments (Lin et al., 2024; Rui, 2023). Understanding whether and how technology use translates educational design into learning performance is therefore essential. To address this gap, this study proposes a synergistic framework integrating entrepreneurship education curriculum, entrepreneurship practice, and the integration of specialization and entrepreneurship (Blackham et al., 2021). Digital technology use is positioned as a central mediating mechanism linking educational inputs to educational performance. In addition, this study examines whether the integration of specialization and entrepreneurship moderates the relationship between entrepreneurship practice and digital technology use, strengthening the effectiveness of practice-based learning in career-relevant contexts (Katsanakis et al., 2024; Feng, 2023; González et al., 2019).

By empirically testing this model using structural equation modeling, this study contributes to entrepreneurship education research by (i) demonstrating the combined and interactive effects of curriculum, practice, and contextual integration, (ii) clarifying the mediating role of digital technology use, and (iii) offering practical guidance for designing entrepreneurship programs aligned with the demands of the digital economy and career-oriented talent development.

Construction of the Theoretical Framework and Proposal of Hypotheses
Deconstruction of Integration Dimensions and Model Development
Entrepreneurship education outcomes do not arise from isolated instructional components but emerge through the interaction of curriculum design, experiential practice, and career-oriented integration. Drawing on entrepreneurship education theory and technology-mediated learning perspectives, this study proposes a synergistic model to explain how these elements jointly influence educational performance (Salah et al., 2020; Fernandes et al., 2020; Lv et al., 2024; Alexander et al., 2024).

Entrepreneurship education curriculum (EC) serves as the foundational input of the proposed framework. It provides structured knowledge, pedagogical guidance, and assessment

mechanisms that shape students' understanding of entrepreneurial concepts and processes. In digitally mediated learning environments, curriculum effectiveness increasingly depends on the integration of digital tools, technology-driven instructional approaches, and competency-based assessments. Such alignment enables students to develop not only conceptual understanding but also the capacity to apply entrepreneurial ideas through digital technologies.

Entrepreneurship practice (EP) represents the experiential dimension of entrepreneurship education. Practice-based learning offers students opportunities to engage in simulations, collaborative projects, and real or semi-real entrepreneurial tasks (Elmessiry et al., 2024). These activities support the transformation of abstract knowledge into actionable skills, particularly through frequent interaction with digital platforms that resemble authentic entrepreneurial environments. Consequently, practice plays a critical role in fostering students' confidence and habitual engagement with digital technologies.

The integration of specialization and entrepreneurship (IEEPE) reflects the extent to which entrepreneurial learning is embedded within disciplinary fields and aligned with career development pathways. This dimension emphasizes interdisciplinary collaboration, industry-informed problem-based learning, and the transfer of entrepreneurial competencies to professional practice. Rather than functioning as an independent driver of outcomes, integration operates as a contextual condition that shapes how effectively curriculum and practice translate into meaningful learning experiences (Huang et al., 2024; Liu et al., 2024; Tkacova et al., 2020; Sharar, 2021).

Digital technology use (UT) is positioned as a central behavioral mechanism within the model, capturing students' actual engagement with digital tools, perceived ease of use, self-efficacy, and learning motivation. In entrepreneurship education, technology use extends beyond a supportive function and constitutes a key process through which educational inputs are transformed into performance outcomes (Jie & Kamrozzaman, 2024). Enhanced digital technology use reflects students' readiness to operate effectively in technology-rich entrepreneurial environments.

Entrepreneurship education performance (EEP) represents the outcome variable of the framework and encompasses learning achievements across cognitive, skill-based, and attitudinal domains, including entrepreneurial competence, application ability, and perceived educational effectiveness.

Figure 1 presents the proposed theoretical model, in which entrepreneurship education curriculum, entrepreneurship practice, and integration of specialization and entrepreneurship jointly influence educational performance through digital technology use. In addition, the model posits that integration of specialization and entrepreneurship moderates the relationship between entrepreneurship practice and digital technology use, strengthening the impact of practice-based learning in technology-rich contexts.
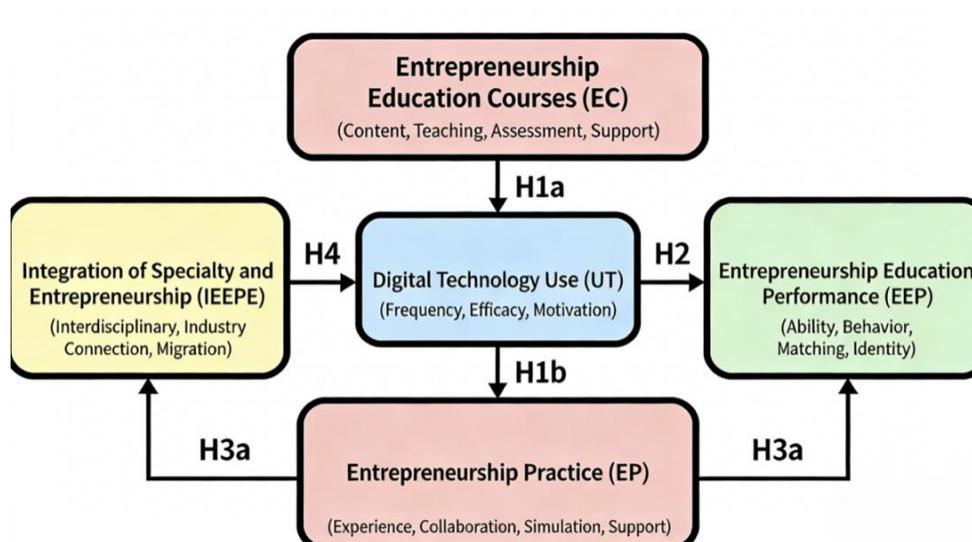
Figure 1. Theoretical Model Diagram of the Synergistic Effect of Curriculum–Practice–Career Integration

Variable Definition and Research Hypotheses

Based on the proposed theoretical framework, this study establishes operational definitions for the core constructs and specifies the hypothesized relationships among them. The measurement items were adapted from established literature to ensure conceptual consistency and content validity.

Entrepreneurship Education Curriculum (EC) refers to the extent to which entrepreneurship courses integrate digital content, technology-supported pedagogical approaches, and competency-based assessment practices. This construct reflects how curriculum design supports the development of entrepreneurial knowledge and digital competencies through instructional strategies, assessment methods, and learning resources.

Entrepreneurship Practice (EP) represents the experiential component of entrepreneurship education and captures students' engagement in practice-oriented activities, including simulations, collaborative projects, and authentic or semi-authentic entrepreneurial tasks. This construct emphasizes the frequency of digital tool use, collaborative learning environments, situational authenticity, and mentor or task-based support provided during practice-based learning experiences (Suchenia et al., 2024)

Integration of Specialization and Entrepreneurship (IEEPE) denotes the degree to which entrepreneurship education is embedded within students' disciplinary fields and aligned with industry contexts and career pathways. This construct highlights interdisciplinary collaboration, the infusion of entrepreneurial elements into subject-specific courses, and the transferability of entrepreneurial competencies to professional practice.

Digital Technology Use (UT) refers to students' actual engagement with digital tools in entrepreneurship learning activities. It encompasses frequency and ease of use, perceived self-efficacy, institutional support conditions, and intrinsic motivation related to technology-mediated learning.

Entrepreneurship Education Performance (EEP) represents the outcome variable of the study and reflects educational achievements across cognitive, skill-based, and attitudinal domains. It includes students' entrepreneurial competencies, application abilities, and perceived learning effectiveness, as evidenced through both internal development and external evaluation (Dirani et al., 2022; Sampaio et al., 2022; Dong & Yu, 2025).

Based on these variable definitions, the following research hypotheses are proposed.
Direct Effects
- **H1a:** Entrepreneurship education curriculum positively affects entrepreneurship education performance.
- **H1b:** Entrepreneurship practice positively affects entrepreneurship education performance.
- **H1c:** Integration of specialization and entrepreneurship positively affects entrepreneurship education performance.

Mediating Effects
- **H2:** Digital technology use positively affects entrepreneurship education performance.
- **H3a:** Digital technology use mediates the relationship between entrepreneurship education curriculum and entrepreneurship education performance.
- **H3b:** Digital technology use mediates the relationship between entrepreneurship practice and entrepreneurship education performance.
- **H3c:** Digital technology use mediates the relationship between integration of specialization and entrepreneurship and entrepreneurship education performance.

Moderating Effect
- **H4:** Integration of specialization and entrepreneurship positively moderates the relationship between entrepreneurship practice and digital technology use, such that higher levels of integration strengthen the effect of practice-based learning on digital technology use.

Table 1
Core Variable Operational Definitions and Measurement Items

Latent Variable	Summary of Measurement Dimensions	Representative Item Orientation
Entrepreneurship Education Curriculum (EC)	Digital content integration; technology-driven pedagogy; competency assessment; resource support	Digital tools integrated into content; using tools to develop ideas; assessment includes digital competencies; teacher demonstration and platforms
Entrepreneurship Practice (EP)	Tool experience frequency; collaborative environment; situational authenticity; mentor and task support	Frequent use of tools; improved team efficiency; simulation of real environments; mentor encouragement and task embedding
Integration of Specialization and Entrepreneurship (IEEPE)	Interdisciplinary collaboration; course infusion; industry/problem linkage; skill transfer	Interdisciplinary group activities; integration of specialization and entrepreneurship; solving real industry problems; skills used for work
Digital Technology Use (UT)	Frequency of use and ease of use; self-efficacy; supporting conditions; intrinsic motivation	Use is intuitive and convenient; confidence in solving difficult problems; school provides training and opportunities; enhances learning motivation

Research Method Design and Empirical Testing

Measurement Model Validation and Data Quality

The sample consisted of **N = 503 students** enrolled in entrepreneurship education courses at **higher education institutions in China.** The participants were primarily **undergraduate students** from diverse disciplinary backgrounds, including **business, management, engineering, and applied sciences.** All respondents had prior exposure to curriculum-based entrepreneurship education and practice-oriented learning activities involving digital technologies (Nishanov et al., 2024). This sample was considered appropriate for examining the proposed relationships among curriculum design, entrepreneurship practice, digital technology use, and educational performance.

Measurement Model Validation and Data Quality

To assess the validity of the theoretical constructs and the reliability of the questionnaire data, this study employed covariance-structure-based confirmatory factor analysis (CFA) to evaluate the proposed five-factor measurement model. The measurement model is expressed as

$$X = \Lambda\xi + \delta$$,

where the observed variable vector X consists of 45 measurement items corresponding to five latent variables (ξ): entrepreneurship education curriculum (EC), entrepreneurship practice (EP), integration of specialization and entrepreneurship (IEEPE), digital technology use (UT), and entrepreneurship education performance (EEP). In this model, Λ represents the factor loading matrix and δ denotes the measurement error (David et al., 2024).

Model identification was ensured by specifying at least three observed indicators for each latent construct. Convergent validity was evaluated based on the statistical significance and

magnitude of standardized factor loadings (λ). Overall model fit was assessed using multiple goodness-of-fit indices, including the chi-square to degrees of freedom ratio (χ^2/df), the root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker–Lewis index (TLI).

The results indicate that the measurement model demonstrates an excellent fit with the empirical data, as shown in Table 2. Composite reliability values ranged from 0.88 to 0.92, exceeding the recommended threshold of 0.70, thereby indicating strong internal consistency among the measurement items (Segredo-Morales et al., 2024). In addition, average variance extracted (AVE) values for all constructs exceeded 0.50, confirming adequate convergent validity. Discriminant validity was further supported by comparing the square roots of AVE values with inter-construct correlations, with the former exceeding the latter for all constructs. Together, these results provide strong evidence that the measurement model is reliable and valid, supporting its use in subsequent structural model analysis.

Table 2
Summary of Measurement Model Reliability and Validity Test Results

Latent Variable	Composite Reliability (CR)	Average Variance Extracted (AVE)
Entrepreneurship Education Curriculum (EC)	0.89	0.51
Entrepreneurship Practice (EP)	0.91	0.53
Integration of Specialization and Entrepreneurship (IEEPE)	0.90	0.52
Digital Technology Use (UT)	0.88	0.50
Entrepreneurship Education Performance (EEP)	0.92	0.55
Model fit indices: χ^2/df = 2.15, RMSEA = 0.047, CFI = 0.943, TLI = 0.935, SRMR = 0.038.		

Structural Model Analysis and Hypothesis Testing
After validating the measurement model, structural equation modeling (SEM) was employed to test the hypothesized relationships in the proposed theoretical framework. The structural model is represented by the equation

$$\boldsymbol{\eta} = \boldsymbol{B\eta} + \boldsymbol{\Gamma\xi} + \boldsymbol{\zeta}$$

where the endogenous latent variables (η) include digital technology use (UT) and entrepreneurship education performance (EEP), and the exogenous latent variables (ξ) include entrepreneurship education curriculum (EC), entrepreneurship practice (EP), and integration of specialization and entrepreneurship (IEEPE). In this formulation, B and Γ denote the structural path coefficient matrices, and ζ represents the structural residuals (Kadirjanovich et al., 2023).

The model specification followed the proposed hypotheses by testing (a) the direct effects of EC, EP, and IEEPE on EEP, (b) the indirect effects of these variables on EEP through UT, and (c)

the moderating effect of IEEPE on the relationship between EP and UT through the inclusion of an interaction term (EP × IEEPE).

The overall goodness-of-fit indices indicate that the structural model fits the data well (χ^2/df = 2.28, RMSEA = 0.049, CFI = 0.937, TLI = 0.930). These values meet commonly accepted thresholds, suggesting that the hypothesized network of relationships is well supported by the empirical data.

The estimated path coefficients, presented in Table 3, reveal several important findings. First, entrepreneurship education curriculum (β = 0.22, $p < 0.01$) and entrepreneurship practice (β = 0.31, $p < 0.001$) have significant positive direct effects on entrepreneurship education performance, providing support for hypotheses H1a and H1b. In contrast, the direct effect of integration of specialization and entrepreneurship on educational performance is not statistically significant (β = 0.08, $p > 0.05$); therefore, hypothesis H1c is not supported.

Second, digital technology use has a strong and significant direct effect on entrepreneurship education performance (β = 0.45, $p < 0.001$), supporting hypothesis H2. In addition, entrepreneurship education curriculum (β = 0.25, $p < 0.001$), entrepreneurship practice (β = 0.40, $p < 0.001$), and integration of specialization and entrepreneurship (β = 0.18, $p < 0.001$) all exert significant positive effects on digital technology use. Bootstrap analysis further confirms that digital technology use significantly mediates the relationships between EC and EEP, EP and EEP, and IEEPE and EEP, thereby supporting hypotheses H3a, H3b, and H3c (Bekebrede & Champlin, 2022).

Finally, the moderating effect analysis shows that the interaction term between entrepreneurship practice and integration of specialization and entrepreneurship has a significant positive effect on digital technology use (β = 0.15, $p < 0.01$). This result indicates that higher levels of integration of specialization and entrepreneurship strengthen the positive effect of entrepreneurship practice on digital technology use, thus providing support for hypothesis H4.

Table 3
Path Coefficients and Hypothesis Testing Results

Hypothesized Path	Standardized Path Coefficient (β)	P value	Conclusion
H1a: EC → EEP	0.22	**	Supported
H1b: EP → EEP	0.31	***	Supported
H1c: IEEPE → EEP	0.08	0.110	Not supported
H2: UT → EEP	0.45	***	Supported
H3a: EC → UT	0.25	***	Supported (UT mediates)
H3b: EP → UT	0.40	***	Supported (UT mediates)

H3c: IEEPE → UT	0.18	***	Supported (UT mediates)
H4: EP×IEEPE → UT	0.15	**	Supported

Model fit indices: χ2/df=2.28, RMSEA = 0.049, CFI = 0.937, TLI = 0.930, SRMR = 0.041.

Note: * p<0.05p < 0.05p<0.05, ** p<0.01p < 0.01p<0.01, *** p<0.001p < 0.001p<0.001.

Synergistic Effect Mechanism and Path Analysis

Testing of Direct Effects and Mediating Effects

The path relationships revealed by the structural model outline a dual mechanism by which educational elements generate performance: entrepreneurship education curriculum and entrepreneurship practice not only produce direct effects on educational performance but also exert significant indirect effects through digital technology use, a key behavioral variable. The direct path coefficients of entrepreneurship education curriculum (β = 0.22) and entrepreneurship practice (β = 0.31) confirm their foundational roles in shaping students' competence and mindset; the strong direct effect shown by digital technology use (β = 0.45) highlights the central position of behavioral transformation in the process of competence output. To accurately quantify indirect effects, the study adopted the mediating effect decomposition formula Indirect Effect=$\beta(a)\times\beta(b)$ for calculation, where $\beta(a)$ represents the effects of EC, EP, and IEEPE on UT, and $\beta(b)$ represents the effect of UT on EEP.

The analysis examining effects in the middle position shows the working mechanism across factors. The approach that combines tools using digital systems with methods that provide flexible development (EC1–EC4) presents structures for understanding to individuals in the study, and practice using direct involvement with environments that create simulation (EP1–EP4) establish conditions for applying this understanding. These two factors together produce increases in how often individuals use systems based on technology and increases in their sense that they can produce effects (UT1–UT6). The process combining area-specific knowledge with activities that develop new business approaches provides additional focus on aims and significance of applying technology through presenting problems from actual industry contexts (IEEPE3, IEEPE5). The behavior using technology serves as the main point that connects changes, turning structured inputs from education into comprehensive abilities that emerge as results (Mario et al., 2022). The effects operating in middle positions show significance (EC → UT → EEP: 0.1125; EP → UT → EEP: 0.180; IEEPE → UT → EEP: 0.081) and support the sequence that includes input of knowledge, change in behavior, and output in performance. This reveals the important role that use of systems based on digital technology occupies in connecting learning that focuses on theory with application that occurs in practice.

Moderating Effect Analysis and Discussion

The study further finds that the promoting effect of entrepreneurship practice on digital technology use is not fixed but is systematically moderated by the level of integration of specialization and entrepreneurship. The results of hierarchical regression analysis, shown in Table 4, indicate that after introducing the interaction term between entrepreneurship practice and integration of specialization and entrepreneurship (EP × IEEPE), the explanatory power (R2) of the model for digital technology use increases significantly (ΔR^2= 0.02, p < 0.01), and the standardized regression coefficient of the interaction term is positive (β = 0.15, p <

0.01). This finding confirms that integration of specialization and entrepreneurship has a significant positive moderating effect, meaning that when practice projects are deeply embedded in interdisciplinary collaboration (IEEPE1, IEEPE6) and real industry contexts (IEEPE3, IEEPE8), students' depth and breadth of digital technology application will be further enhanced.

The presence of this condition affecting the relationship provides the practice component with more substantial meaning, and the degree to which it shows effects depends on the features of the context that relate to work settings. When the level of combining the specialized field with the approach is low, practice focuses on developing skill in using tools; when this level is high, using such tools connects to addressing problems from actual work settings that involve multiple fields (IEEPE5, IEEPE8). This feature of the context, following the theory examining learning in settings, increases the extent to which learning shows meaning and allows participation. High levels of this combination produce a setting for learning that resembles work contexts that individuals encounter in the future, and this reflects the theory of transfer from training indicates as important, allowing the capabilities that develop through practice to change more readily into sustained ability to perform in occupational settings (Halaburda, 2024). As a main variable describing the context, the central function of combining the specialized field with the approach involves improving the features of how the practice component is designed, and this increases the degree to which practice affects the behavior that uses such capabilities.

Table 4
Hierarchical Regression Analysis Results for the Moderating Effect

Variable	Model 1 (β)	Model 2 (β)	Model 3 (β)
Control variables	Controlled	Controlled	Controlled
Entrepreneurship Practice (EP)		0.38***	0.35***
Integration of Specialization and Entrepreneurship (IEEPE)		0.16**	0.15**
EP × IEEPE			0.15**
R^2	0.01	0.32	0.34
ΔR^2		0.31***	0.02**

Discussion
This study examined how entrepreneurship education curriculum, entrepreneurship practice, and the integration of specialization and entrepreneurship jointly influence educational performance, with digital technology use serving as a central mediating mechanism. The findings support a synergistic framework in which educational inputs interact through technology-mediated learning behaviors to generate meaningful outcomes, consistent with prior entrepreneurship education and technology-supported learning research (Salah et al., 2020; Fernandes et al., 2020; Lv et al., 2024; Alexander et al., 2024).

Direct Effects of Curriculum and Practice on Educational Performance
The results indicate that both entrepreneurship education curriculum and entrepreneurship practice exert significant direct effects on educational performance, highlighting the foundational roles of structured curriculum design and experiential learning in developing students' entrepreneurial competencies. Curriculum that integrates digital content,

technology-supported pedagogy, and competency-based assessment directly enhances students' understanding and application of entrepreneurial knowledge, aligning with evidence on digitally enriched curriculum design (Alexander et al., 2024; Salah et al., 2020). Likewise, practice-based activities such as simulations and collaborative projects enable students to transform conceptual learning into practical skills, thereby improving educational outcomes, which is consistent with prior findings on experiential and practice-oriented learning (Elmessiry et al., 2024; Fernandes et al., 2020).

In contrast, the integration of specialization and entrepreneurship does not demonstrate a significant direct effect on educational performance. This suggests that integration alone does not automatically improve learning outcomes. Rather than functioning as an independent driver, integration appears to shape the conditions under which curriculum and practice become effective. This finding helps explain inconsistent results in earlier studies and aligns with research emphasizing that interdisciplinary and career-oriented integration requires alignment with pedagogy and learning activities to generate measurable outcomes (Huang et al., 2024; Liu et al., 2024; Tkacova et al., 2020; Sharar, 2021).

Digital Technology Use as a Central Mediating Mechanism
A key contribution of this study lies in identifying digital technology use as a strong mediating variable linking educational design to performance outcomes. Digital technology use shows a substantial direct effect on educational performance and significantly mediates the relationships between curriculum, practice, integration, and learning outcomes. This result supports the view that technology use is not merely supportive but constitutes a central behavioral pathway through which educational inputs are translated into competence and performance (Jie & Kamrozzaman, 2024).

These findings indicate that curriculum design and practice activities enhance educational performance primarily by promoting students' active engagement with digital tools. In entrepreneurship education, learning outcomes are generated not merely through exposure to content or participation in activities but through behavioral involvement in technology-mediated tasks. This perspective aligns with action-based and technology-mediated learning approaches, which emphasize learners' active application of digital tools in authentic contexts (Fernandes et al., 2020; Lv et al., 2024).

Moderating Role of Integration of Specialization and Entrepreneurship
The findings further reveal that the integration of specialization and entrepreneurship positively moderates the relationship between entrepreneurship practice and digital technology use. Practice-based learning becomes more effective in fostering technology use when embedded within interdisciplinary and career-relevant contexts. When practice activities are closely aligned with students' disciplinary backgrounds and real industry problems, digital tools are perceived as meaningful rather than optional. This result is consistent with studies highlighting the importance of disciplinary alignment and industry-informed learning environments in strengthening student engagement and technology application (Huang et al., 2024; Liu et al., 2024).

Integration therefore enhances the relevance and authenticity of experiential learning, strengthening students' motivation to engage deeply with technology. From a theoretical

perspective, this moderating effect supports learning transfer frameworks, suggesting that educational experiences resembling real-world professional environments are more likely to produce sustained behavioral change (Tkacova et al., 2020; Sharar, 2021).

Theoretical Contributions
This study contributes to entrepreneurship education research in several important ways. First, it moves beyond single-factor explanations by empirically demonstrating a synergistic mechanism linking curriculum, practice, and career integration through digital technology use. Second, it reconceptualizes digital technology use as a central behavioral process rather than a peripheral support tool. Third, it clarifies the role of integration of specialization and entrepreneurship as a contextual moderator, helping to explain why integration initiatives yield uneven results when implemented without aligned practice and technology use.
By revealing these relationships, the study provides a more comprehensive understanding of how entrepreneurship education produces outcomes in the digital era.

Practical Implications
The findings offer clear implications for higher education institutions and educators. Entrepreneurship education programs should move beyond isolated curriculum reform or practice activities and instead adopt integrated designs that actively promote students' use of digital technologies. Educators should ensure that digital tools are embedded within both curriculum content and practice tasks, supported by authentic, discipline-relevant problems. In addition, institutions should strengthen the integration of specialization and entrepreneurship by aligning practice projects with industry contexts and career pathways. Such integration enhances the effectiveness of practice-based learning and supports sustained engagement with digital technologies, ultimately leading to improved educational performance.

Conclusion
This study investigated how entrepreneurship education curriculum, entrepreneurship practice, and the integration of specialization and entrepreneurship jointly influence educational outcomes in the digital learning context. By incorporating digital technology as a central mediating mechanism, the study provides a more comprehensive explanation of how educational design is translated into effective learning performance.

The findings demonstrate that both entrepreneurship education curriculum and entrepreneurship practice exert significant direct effects on educational performance. More importantly, their influence is strengthened through students' active use of digital technology, highlighting technology use as a key behavioral pathway through which educational inputs produce learning outcomes. In contrast, the integration of specialization and entrepreneurship does not directly enhance educational performance. Instead, it functions as a contextual condition that strengthens the relationship between practice-based learning and digital technology use.

These results indicate that entrepreneurship education outcomes are not generated by isolated curriculum reform or practical activities alone. Rather, they emerge from a synergistic process in which curriculum, practice, and career-oriented integration interact through

technology-mediated learning behaviors. Digital technology use plays a pivotal role in converting structured educational inputs into observable competence and performance.

From a theoretical perspective, this study advances entrepreneurship education research by proposing and empirically validating a synergistic framework that links educational inputs, behavioral processes, and learning outcomes. It reconceptualizes digital technology use as a core mechanism rather than a supplementary tool and clarifies the role of integration of specialization and entrepreneurship as a moderating factor that enhances the effectiveness of experiential learning.

Practically, the findings suggest that higher education institutions should design entrepreneurship education programs that integrate digital technologies across curriculum and practice while aligning learning activities with disciplinary and career contexts. Embedding practice tasks within real or simulated industry problems can strengthen students' engagement with digital tools and improve educational effectiveness.

All in all, this study makes three key contributions to entrepreneurship education research. It breaks away from the limitations of fragmented single-factor studies by developing and validating a synergistic framework that brings together curriculum design, experiential practice, and career-oriented integration, it positions digital technology use as a core behavioral mediator connecting educational inputs to performance, instead of treating it as a secondary tool, and it clarifies that the integration of specialization and entrepreneurship (IEEPE) acts as a moderator. Specifically, IEEPE boosts how practice influences digital technology use, which clears up conflicting results from earlier research. Contextually, the findings address the needs of China's higher education amid digital economic changes and shifting employment requirements, where entrepreneurship education is increasingly moving toward interdisciplinary, technology-infused, and career aligned models. Matching global trends in entrepreneurship education, it bridges the gap between theoretical models and real-world practice, offering actionable guidance for curriculum reform and program design tailored to the digital era. These insights also hold relevance for educators in other emerging economies or technology-driven educational settings.

Despite these contributions, this study has limitations. The data were collected from a specific educational context and relied on self-reported measures, which may limit generalizability. Future research may extend this model by employing longitudinal designs, objective performance indicators, or cross-institutional and cross-national comparisons to further validate the proposed framework.
Overall, this study offers both theoretical insight and practical guidance for developing entrepreneurship education models that are better aligned with digital transformation and career-oriented talent development.

References

González, J., Sanz-Calcedo, G., Cruz García, C., B. M., J., López Pérez, O., et al. (2019). A teaching methodology for the real-time assessment of students' competencies related to manufacturing subjects using technology based on electronic devices. *Procedia Manufacturing, 41*, 579–586.

Alexander, C. H. C., Sivakumar, S., & Kumar, S. P. S. (2024). Gamification in CAD learning: A methodological approach for engineering curriculum. *AIP Conference Proceedings, 3161*, 020169.

Bekebrede, G., & Champlin, C. (2022). Frame game as teaching methodology in higher education: The case of relasticity. Springer. https://doi.org/10.1007/978-3-031-08041-3

Blackham, R. E., Rosenthal, R. J., Higa, K., Gagner, M., & Hamdorf, J. M. (2021). Development of an international standardized curriculum for laparoscopic sleeve gastrectomy teaching utilizing modified Delphi methodology. *Obesity Surgery*.

Camilo Quintáns Graa, M., Gómez Fernández, M., Valdés Pea, M. D., & Acevedo, J. M. (2024). Methodology and resources for the practical teaching of mixed analog-digital circuits. In *2024 XVI Congreso de Tecnología, Aprendizaje y Enseñanza de la Electrónica (TAEE)* (pp. 1–10).

David, H. I., Rodrigo, C. M., Aures-García, Á., Luz, C. Z., Adelaida, B. L., & Neil, C. C. (2024). Development of a video game for teaching good project management practices to undergraduate students using the agile Scrum methodology and gamification techniques. In *2024 IEEE XXXI International Conference on Electronics, Electrical Engineering and Computing (INTERCON)* (pp. 1–8).

Dirani, E., Manrique, A. L., & Campos, L. C. (2022). The management of teaching and assessment: Analysis of a biomedical engineering course using the PBL methodology.

Dongchu, T., & Yuhao, L. (2025). Research on the "practical jurisprudence" teaching system in China's civil procedure law: With a focus on the cultivation of the Juris Master (for non-law graduates). *Contemporary Social Sciences*.

Elmessiry, Z., Elsabry, E. H., Khoriba, G., & Ezzat, M. O. (2024). Utilizing data science to analyze student performance trends in STEM education: Insights for enhancing curriculum design. In *2024 International Mobile, Intelligent, and Ubiquitous Computing Conference (MIUCC)* (pp. 37–42).

Feng, J. (2023). Exploration and implementation of AI general course in Guangzhou Information Technology Vocational School. In *Proceedings of the 27th Global Chinese Conference on Computers in Education*.

Fernandes, C. C., Orivaldo V. S. Júnior, Oliveira, D., Garcia, L. T. S., Burlamaqui, A. M. F., Melo, J. C. P., et al. (2020). Demystifying educational robotics with FOCORE: From very low cost software and hardware technologies to the development of new methodologies and curriculum for continuing teacher education and teaching of Brazilian basic education students. In *Brazilian Symposium on Robotics; Latin American Robotics Symposium; Workshop of Robotics in Education*.

Halaburda, I. I. (2024). Methodology of teaching sociology for students of technical colleges. In *Global Scientific Trends in History, Political Science, Sociology, and Philosophy* (pp. 58–60).

Huang, Q., Song, W., Li, J., & Huang, G. (2024). A study of measuring student classroom engagement in a STEAM curriculum. In *2024 6th International Conference on Computer Science and Technologies in Education (CSTE)* (pp. 319–323).

Jie, A. L. X., & Kamrozzaman, N. A. (2024). The challenges higher education students face in using artificial intelligence (AI) against their learning experiences. *Open Journal of Social Sciences, 12*(10), 362–387.

Kadirjanovich, A. R., Isayevna, A. N., Gulomjonovna, P. G., & Qizi, P. S. B. (2023). Improving the methodology of teaching specialized subjects in the preparation of future computer engineering on the basis of innovative technologies. In *2023 8th International Conference on Computer Science and Engineering (UBMK)* (pp. 125–130).

Kamrozzaman, N. A., & Jie, A. L. X. (2025). Converging heutagogy, M-learning, and AI for sustainable language education: A fuzzy Delphi study. *Edelweiss Applied Science and Technology, 9*(9), 1600–1608.

Katsanakis, N., Wang, Y., & Affejee, Y. (2024). Generative AI in higher education: Graduate teaching assistants' practice and reflection on ChatGPT for module assessment. In *UK and Ireland Engineering Education Research Network Conference Proceedings 2023*.

Lin, M., Zheng, Z., & Chen, J. (2024). Exploration of AIGC-assisted reform in Linux operating system curriculum teaching. In *2024 2nd International Conference on Mechatronics, IoT and Industrial Informatics (ICMIII)* (pp. 151–155).

Liu, C., Li, X., Yuan, J., Li, Y., & Duan, L. (2024). Exploration and practice of project-based classroom teaching reform with the support of knowledge graph: A case study of the "Logic Algebra and Digital Circuits" course. *Higher Education and Practice, 1*(2), 45–49.

Lv, K., Yue, W., Yang, W., & Chen, Z. (2024). Logical path and implementation effect of ideological and ethical curriculum with different courses with the same value mode. *Advances in Transdisciplinary Engineering*.

Mario, L. D. L. C. K., Roque-Coronel, L. M., Noa-Copaja, S. J., & Rejas-Junes, L. R. (2022). Flipped classroom methodology in English language learning in higher education. In *International Conference on Information Technology & Systems*. Springer.

Moraes, V. M. D., Paoliello, C., & Mourato, J. M. (2025). Reshaping design education: Curriculum diversification for a pluriversal pedagogy. *Springer Series in Design and Innovation* (pp. 481–494).

Nishanov, A., Allamov, O., Yusupova, J., Matyakubov, M., Qalandarov, B., & Bahrom, R. (2024). Methodology of teaching programming science through online platforms. In *2024 IEEE 3rd International Conference on Problems of Informatics, Electronics and Radio Engineering (PIERE)* (pp. 1410–1413).

Rui, Z. (2023). Research methodology and analysis of innovative pedagogical models in mechanical engineering courses for international students at the School of Mechanical Engineering and Automation, Beihang University. *Contemporary Social Sciences, 8*(5).

Salah, B., Khan, S., Ramadan, M., & Gjeldum, N. (2020). Integrating the concept of Industry 4.0 by teaching methodology in industrial engineering curriculum. *Processes*.

Sampaio, A. Z., Farinha, T. T., & Gomes, A. M. (2022). Introduction of BIM methodology in structural engineering education. *Technological Innovation in Engineering Research, 4*, 21–30.

Segredo-Morales, E., Oliver Díaz, & González, E. (2024). The problem-based teaching methodology applied to the reformulation of laboratory practices. In *INTED Proceedings* (Vol. 1, pp. 1027–1030).

Sharar, T. (2021). Rethinking global education approaches and practices: A critical review of curriculum in action at secondary and higher secondary schools in Pakistan. *JETT, 12*(4), 101–111.

Suchenia, A., Suchenia, K., Adrian, M., Jobczyk, K., Winiewski, P., & Ligza, A. (2024). Order selection methodology of OMG diagrams in teaching designing information systems. *Lecture Notes in Business Information Processing*, 365–374.

Tkacova, Z., Snajder, L., & Gunis, J. (2020). Artificial intelligence – A new topic in computer science curriculum at primary and secondary schools: Challenges, opportunities, tools and approaches.