The Evolution of Entrepreneurship Education in the Digital Era: A Bibliometric Roadmap of AI-Driven Experiential Learning (2016–2026).

Purpose: The purpose of this paper is to examine the evolution of AI-driven experiential learning in entrepreneurship education in the digital era and to identify the main research trends, intellectual foundations and future directions shaping the field.

Design/Methodology/approach: The study adopts a bibliometric approach using 204 Web of Science-indexed articles and reviews published between 2016 and June 2026. Performance analysis and science mapping were conducted using VOSviewer 1.6.20, including publication trajectory, source performance, co-citation, document citation, author productivity, keyword co-occurrence and overlay analyses.

Findings: The findings show that the field has shifted from limited early activity to rapid expansion during 2024–2026, driven by growing attention to generative AI, AI literacy and educational technology. Three knowledge bases are identified: educational technology and digital pedagogy; entrepreneurship, business and management education; and sustainability-oriented transformation. Five thematic clusters further highlight behavioural competency, AI integration in higher education, socio-technical adaptation, crisis-driven experiential learning and student-centred instructional design.

Originality/Value: The paper contributes a bibliometric research roadmap for AI-driven experiential entrepreneurship education by identifying the field's intellectual structure, thematic development and future research directions. It positions AI not only as a digital tool, but as part of a wider pedagogical shift toward adaptive, responsible and precarity-aware entrepreneurial learning ecosystems.

Keywords: Entrepreneurship education; Experiential learning; Artificial intelligence; AI literacy; Bibliometric analysis; Work-based learning; Precarity

1.Introduction

Artificial Intelligence (AI) is commonly understood as a system's ability to interpret external data, learn from it and adapt to achieve specific goals (Kaplan and Haenlein, 2019; Norbäck and Persson, 2024). It encompasses techniques such as natural language processing and machine learning, enabling machines to imitate aspects of human cognition and process large datasets (Haenlein and Kaplan, 2019; Brown *et al*., 2024). In entrepreneurship education (EE), AI can support experiential learning through market simulation, rapid feedback and data-informed decision-making (Triantoro *et al*., 2025). Adaptive and algorithmic tools can also provide pedagogical support and help student entrepreneurs identify market anomalies and respond to business problems (Davenport and Ronanki, 2018; Thayyib *et al*., 2023).

AI has consequently attracted growing attention in entrepreneurial pedagogy and digital transformation (Wasim et al., 2024; Kopalle *et al*., 2022). Existing research has examined digital transformation in educational and entrepreneurial contexts, including work-based learning (Morris and König, 2020), precarity in the digital gig economy (Haj Youssef and Sayour, 2025; Ukanwa *et al*., 2022), and context-dependent entrepreneurial orientation (Haj Youssef *et al*., 2026). However, despite growing AI-related research, there remains a need to synthesise how AI is shaping entrepreneurship education. Reviews in marketing (Chintalapati and Pandey, 2022) and operations (Dhamija and Bag, 2020) do not address the longitudinal development of AI-driven experiential learning in entrepreneurship education, particularly in precarious and global contexts (Thayyib *et al*., 2023; Wasim *et al*., 2024).

Recent reviews address parts of this intersection but differ from the present study. Motta and Galina (2023) review experiential learning in entrepreneurship education but predate the recent expansion of generative AI. Chen *et al*. (2024) focus on AI technologies, educational purposes and pedagogical design, Anubhav *et al*. (2024) provide a broader review of entrepreneurship education in higher education between 2002 and 2022, and *Yu et al*. (2025) examine generative AI specifically. Collectively, these studies do not explain the field's longitudinal development from digital transformation toward generative AI, the evolution of its intellectual foundations, or its connections with experiential and work-based learning and increasingly precarious employment contexts.

Entrepreneurship education also presents pedagogical challenges that differ from many other areas of higher education. Students are expected not only to acquire knowledge, but also to identify opportunities, test assumptions, make decisions under uncertainty and learn through action and reflection (Motta and Galina, 2023; Neck and Corbett, 2018). AI therefore raises questions beyond technology adoption or teaching efficiency, including how entrepreneurial judgement develops when decision-making is AI-supported and whether experiential and market-facing characteristics can be preserved. These features make this intersection sufficiently distinct to warrant focused analysis.

Recognising this gap, a bibliometric review can provide a structured overview of the field's development, intellectual foundations and emerging themes, while identifying underdeveloped areas such as algorithmic precarity and human-AI hybrid experiential learning (Votto *et al.,* 2021). This is important for researchers seeking future directions and educators considering how AI can be used within experiential entrepreneurship curricula.

To address this gap, the current study maps the evolution of AI-driven experiential learning in entrepreneurship education between 2016 and 2026. It examines publication trajectories, influential sources, co-citation structures and keyword co-occurrence patterns to identify the fields intellectual foundations and emerging thematic directions. It develops a research roadmap linking AI, experiential learning and precarious global contexts are reshaping the future direction of entrepreneurship education. In contrast to broader reviews of AI in higher education and thematic reviews of AI applications in entrepreneurship education, the study provides a longitudinal bibliometric perspective integrating publication development,

intellectual structure and thematic evolution with experiential, work-based and precarious dimensions of entrepreneurial learning.

1.1 The Changing Landscape of Entrepreneurship Education

Entrepreneurship education (EE) has transitioned from a niche business school elective to a global, multidisciplinary priority, reflecting the growing attention to how innovation is fostered within higher education (Nabi *et al*., 2017; Wasim *et al*., 2024).While early approaches focused on functional business skills and linear business plans;the contemporary EE emphasises the development of an "entrepreneurial mindset" through socially embedded and network-driven learning (Motta and Galina, 2023; Neck and Corbett, 2018). This reflects a broader shift from teaching about entrepreneurship toward learning through entrepreneurial activity, requiring students to engage with opportunity recognition, experimentation, problem-solving and decision-making under uncertainty. Despite the growth of EE research, an "impact gap" remains between pedagogical theory and the creation of high-growth ventures (Nabi et al., 2017). The shift also aligns with wider movement toward experiential and work-related learning, where students apply knowledge in complex contexts (Morris and König, 2020; Motta and Galina, 2023).Recent evidence further suggests that work-based learning can strengthen employability-related skills through autonomy, competence and meaningful engagement in applied learning contexts (Parenrengi et al., 2025).

Experiential entrepreneurship education therefore emphasises the process through which students act, receive feedback, reflect and adapt. Its value lies not only in producing viable entrepreneurial solutions, but also in developing judgement, resilience and the capacity to respond when assumptions or actions do not produce expected outcomes. Entrepreneurship is therefore increasingly understood as a dynamic process of learning by doing within complex social ecosystems (Motta and Galina, 2023; Neck and Corbett, 2018).

1.2 Digital Transformation and AI in Higher Education

Digital transformation and AI have become increasingly important in higher education, particularly as institutions seek new ways to support learning, assessment and student engagement (Obschonka and Audretsch, 2020; Collins *et al*., 2021). Digital transformation extends beyond the adoption of tools, reflecting changes in how knowledge is created, shared and applied across human and technological actors (Norbäck and Persson, 2024). Within entrepreneurship education, AI can support market simulation, sentiment analysis, rapid prototyping and feedback, narrowing the distance between classroom learning and market-facing entrepreneurial activity (Triantoro et al., 2025; Obschonka and Audretsch, 2020). Recent evidence also suggests that AI integration can strengthen entrepreneurial capabilities, including opportunity sensing, seizing and resource reconfiguration in AI-enabled business environments (Gong et al., 2025).

However, the pedagogical implications extend beyond access to new tools. When students use AI to generate ideas, analyse markets, test assumptions or support decisions, parts of the entrepreneurial process become technology mediated. This raises questions about what students learn, how much judgement remains with the learner, and whether AI strengthens or reduces engagement with uncertainty and experimentation. Existing research has often emphasised technological benefits, with less attention to how AI may alter the philosophy and practice of experiential learning (Crompton and Burke, 2023). The educational challenge is not simply how AI can be integrated into entrepreneurship teaching, but how it can support without weakening the experiential processes through which entrepreneurial capability is develops. Student agency, critical evaluation of AI-generated outputs, reflective learning and responsible decision-making therefore become central to AI-supported entrepreneurship education

1.3 Precarity and the Need for Experiential Learning

Despite the opportunities offered by AI, an important gap remains in understanding how digital advancements address precarious entrepreneurial contexts (Haj Youssef and Sayour, 2025). The rise of the digital gig economy and algorithmic management has introduced new forms of precarity, where entrepreneurial stability is increasingly shaped by volatility, platform dependence and economic uncertainty (Haj Youssef *et al*., 2026; Ukanwa *et al*., 2022). Consequently, there is a growing need for experiential learning approaches that immerse students in real-world problem-solving and help develop psychological and operational resilience (Morris and König, 2020; Haj Youssef *et al*., 2026). While digital tools can support these experiences through simulation and virtualisation, the precarity literature suggests that technology alone cannot replace the socially embedded networks, judgment and contextual awareness required to succeed in uncertain environments (Haj Youssef and Sayour, 2025; Baijou *et al*., 2026). The challenge for entrepreneurship educators, therefore, is to use AI not only for efficiency, but also to support students in navigating structural inequalities, unstable labour markets and the precarious nature of modern work-based learning (Ukanwa *et al*., 2022; Wasim *et al*., 2024).

2.Methodology

This study adopts a bibliometric approach to examine research at the intersection of artificial intelligence, experiential learning and entrepreneurship education. Bibliometric analysis enables the systematic assessment of publication patterns, citation structures and thematic relationships across a defined corpus (Cobo *et al*., 2011; Donthu *et al*., 2021). Following Donthu *et al*. (2021), the study combines performance analysis with relational science mapping to identify the field's publication trajectory, influential sources, intellectual foundations and emerging thematic clusters.

2.1 Data Source and Search Strategy

The data were retrieved from the Web of Science (WoS) Core Collection, because of its established use in bibliometric research and its coverage of peer-reviewed journals across education, business, management and technology-related fields (Donthu *et al*., 2021; Mongeon and Paul-Hus, 2016).

The search strategy captured the intersection between entrepreneurship education, digital technologies and AI, and experiential or work-based learning contexts. The following Boolean search string was applied:

> TS=("Entrepreneurship Education" OR "Entrepreneurial Learning" OR "Graduate Entrepreneurship" OR "Higher Education") AND ("Artificial Intelligence" OR "AI" OR "Generative AI" OR "Large Language Models" OR "LLM" OR "Digital Transformation" OR "Digital Era") AND ("Experiential Learning" OR "Work-Based Learning" OR "Learning-by-doing" OR "Action Learning" OR "Precarity" OR "Gig Economy" OR "Resilience").

The Web of Science search was conducted on 8th June 2026. and covered publications from 1 January 2016 to 1 June 2026. This period captures the development from early stages of digital transformation in higher education to the recent expansion of generative AI and large language models. The initial search generated 229 documents.

2.2 Inclusion and Exclusion Criteria

A multi-stage screening process was applied following Donthu *et al*.(2021). Documents were included if they directly addressed the application, integration or impact of AI and digital technologies within entrepreneurial learning, higher education, work-based learning or related experiential pedagogical contexts. Relevance was assessed through manual screening of titles and abstracts to confirm that each study demonstrated a clear connection to entrepreneurship education, entrepreneurial learning, experiential or work-based learning, or closely related higher education contexts. Studies discussing AI or digital transformation without a substantive educational or entrepreneurial learning dimension were excluded.

The dataset was limited to English-language publications peer-reviewed articles and reviews. Conference proceedings, editorials, book reviews and other non-research outputs were excluded, together with unrelated technical, medical or engineering studies lacking an explicit connection to higher education, management, entrepreneurship, work-based learning or socio-economic transformation. Following the application of these criteria and manual screening of off-topic records, the initial 229 documents were reduced to 204 sources for analysis. The screening process is presented in Figure 1.

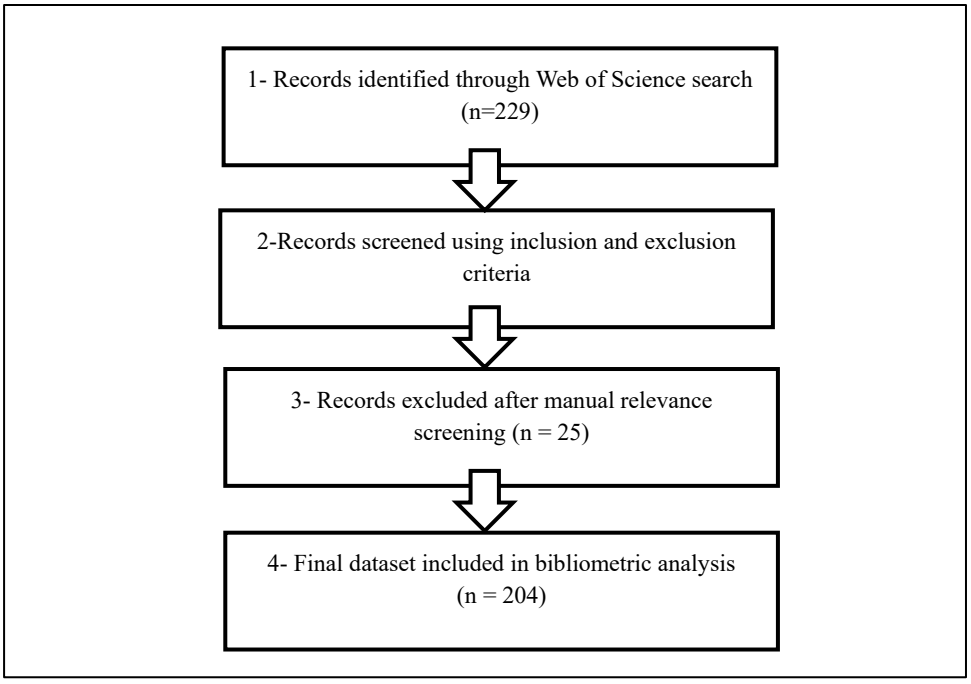


Figure 1: Study selection and screening process

2.3 Data Cleaning and Bibliometric Mapping

The 204 sources were cleaned and standardised to before analysis. Author keywords and KeyWords Plus were harmonised by merging synonymous terms, spelling variations and acronyms into unified descriptors. For example, terms such as “Artificial Intelligence”, “AI” and “artificial intelligence” were consolidated under a single parent term. Related terms such as “Generative AI” and “Large Language Models” were also standardised and author names were also reviewed to address indexing inconsistencies.

The cleaned dataset was analysed using VOSviewer (v. 1.6.20) with full counting. Performance analysis examined publication growth, source productivity, citation impact and author contributions, while relational science mapping identified the intellectual and conceptual structure through journal co-citation and keyword co-occurrence analyses.

Together, these techniques enabled the study to trace both the development trajectory and the thematic evolution of AI-driven experiential learning in entrepreneurship education.

3.Results and Network Analysis

3.1 Publication Trajectory and Subject Evolution (2016-2026)

The chronological distribution of the 204 selected documents reveals a non-linear growth trajectory, with AI-driven experiential entrepreneurship education moving from a peripheral topic to an increasingly visible research domain. As shown in Figure 2, the publication pattern can be divided into three phases: the Early Stage or pre-disruptive baseline (2016–2020), the Digital Acceleration Phase (2021–2023), and the Algorithmic Integration Era (2024–2026). These labels reflect both changes in publication activity and shifts in the dominant technological and pedagogical focus of the literature across the three periods. The conceptual characteristics of these phases are presented in Figure 3.

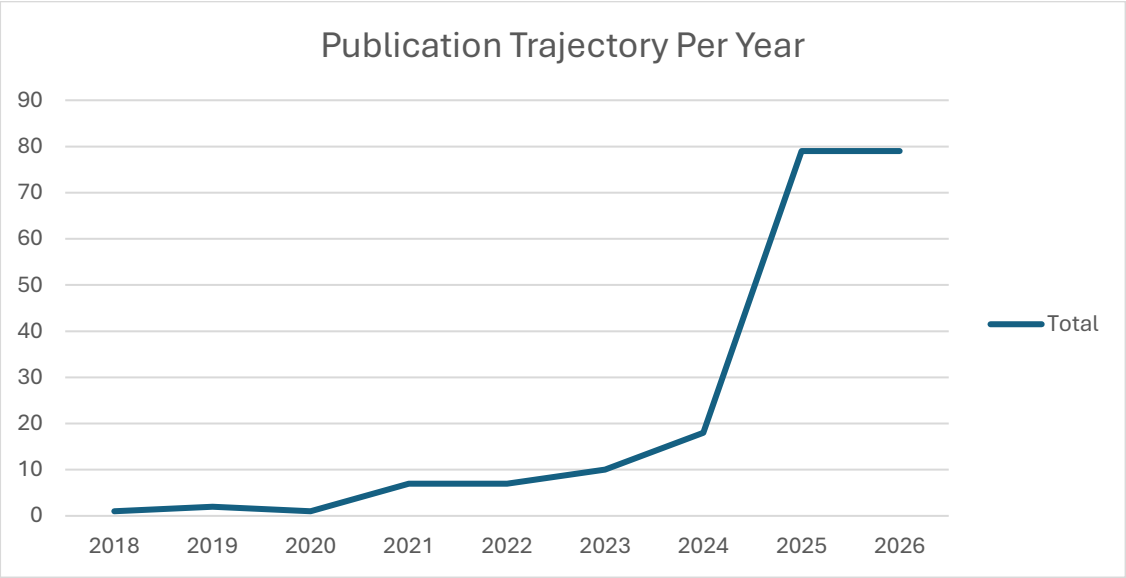


Figure 2. Annual distribution and growth trajectory of publications on digital transformation in entrepreneurship education (2016–June 2026).

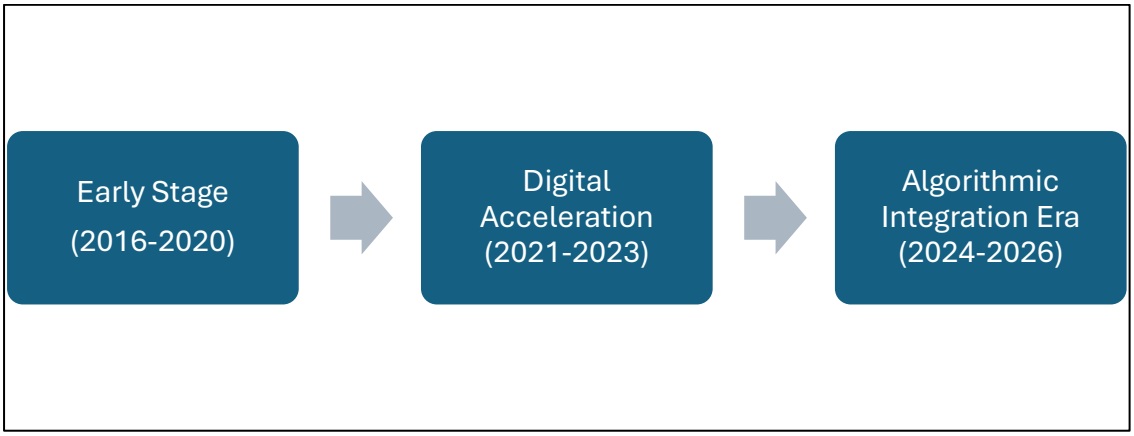


Figure 3. Conceptual schematic of literature evolution phases in AI-driven experiential entrepreneurship education.

During the Early Stage (2016–2020), output remained very limited, with no records in 2016 and 2017 and only four publications across 2018–2020. The Digital Acceleration Phase (2021–2023) shows a gradual growth, with publications rising from seven in 2021 to ten in 2023reflecting wider digitalisation of higher education and the growing attention to digitally supported entrepreneurial learning following the COVID-19 disruption. The strongest expansion occurred during the Algorithmic Integration Era (2024–2026) with publications increased to 18 in 2024 and to 79 in both 2025 and in the first half of 2026. Together, 2025 and 2026 account for approximately 77.4% of the full corpus. This concentration reflects growing attention to generative AI, AI literacy, automated learning technologies and the redesign of entrepreneurial competencies and experiential pedagogies.

3.2 Contribution and Citation Impact of Journals

3.2.1 Country-level research productivity

A country-level analysis was conducted using a minimum threshold of five publications per country, resulting in 17 countries meeting the inclusion criterion. Among the ten most productive countries, China recorded the highest publication output with 30 documents, followed by the USA (24), England (20), India (17) and Australia (15). China also recorded the highest citation count (999), followed by Australia (360), the USA (348) and England (268). Overall, the results show that research in this area is internationally distributed, with notable contributions from countries across Asia, Europe, North America, and Australia.

3.2.2 Source Publication Performance

To identify the journals shaping research on AI, digital transformation and entrepreneurship education, a minimum threshold of two documents per source was applied in VOSviewer. This produced a focused set of journals spanning education, educational technology, management learning, sustainability and digital transformation.

Source Journal	Documents	Citations	Average Citation Per Document	Total Link Strength
Sustainability	16	8	0.5	1
Education Sciences	13	205	15.77	6
Frontiers In Education	6	65	10.83	0
Computers And Education: Artificial Intelligence	5	74	14.80	3
Higher Education Skills And Work-Based Learning	5	0	0	1
International Journal Of Management Education	5	225	45	2
Cogent Education	4	1	0.25	3
Engineering	4	941	235.25	0
Frontiers In Psychology	4	7	1.75	1
European Journal Of Education	3	2	0.67	0

Table 1. Performance matrix of prominent publishing sources (ranked by volume output).

As shown in Table 1, *Sustainability and Education Sciences* are the most productive outlets. However, publication volume does not necessarily correspond with citation impact. *Education Sciences* shows stronger citation performance, while *Sustainability* has a lower average citation rate, which may partly reflect the recency of publications in this fast-growing field. By contrast, journals with fewer publications, such as *Engineering and the International Journal of Management Education*, show substantially higher citation averages, suggesting that a smaller number of influential papers have shaped the domain.

The presence of *Computers and Education: Artificial Intelligence, Frontiers in Education and Higher Education, Skills and Work-Based Learning* further illustrates the interdisciplinary character of the field, spanning digital education, management education, sustainability and work-based learning.

3.2.3 Co-Citation Network Map/Cluster

To examine the intellectual foundations of the field, a journal co-citation analysis was conducted using a minimum citation threshold of 20. In total, 57 journals met this threshold, forming three interconnected clusters (Figure 4).

The first cluster (Red), **Educational Technology, Digital Pedagogy, and Higher Education Frameworks**, represents the largest knowledge base in the network. It is anchored by journals concerned with computing, educational technology, digital learning environments and higher education pedagogy, including *Computers & Education*, *Education and Information Technologies*, *British Journal of Educational Technology* and *International Journal of Educational Technology in Higher Education*. This cluster indicates that AI-driven entrepreneurship education is strongly informed by research on digital learning infrastructures, intelligent systems, user engagement and technology-supported pedagogy.

The second cluster (Green), **Business, Entrepreneurship Education, and Management Training,** reflects the management and enterprise education foundations of the field. It includes entrepreneurship and management learning outlets such as *Journal of Business Venturing*, *Journal of Business Research*, *Small Business Economics*, *Academy of Management Learning & Education*, *International Journal of Management Education* and *Higher Education, Skills and Work-Based Learning*. This cluster positions entrepreneurship education as a practice-oriented field concerned with entrepreneurial mindset development, curriculum design, employability and the alignment between higher education and changing labour-market needs.

The third cluster (Blue), **Sustainability, Open Science, and Multidisciplinary Direction**, captures the broader socio-technical and global context in which the field is developing. Journals such as *Sustainability*, *Journal of Cleaner Production* and *International Journal of Sustainability in Higher Education* show the connection between entrepreneurship education, sustainable development and institutional transformation. The presence of wider multidisciplinary sources further suggests that the field is being shaped by debates beyond education and management alone.

Overall, the co-citation structure reveals a triadic intellectual base combining educational technology, entrepreneurship and management education, and sustainability-oriented research. This reinforces the interdisciplinary character of AI-driven experiential entrepreneurship education and the need to integrate technological, pedagogical and societal perspectives.

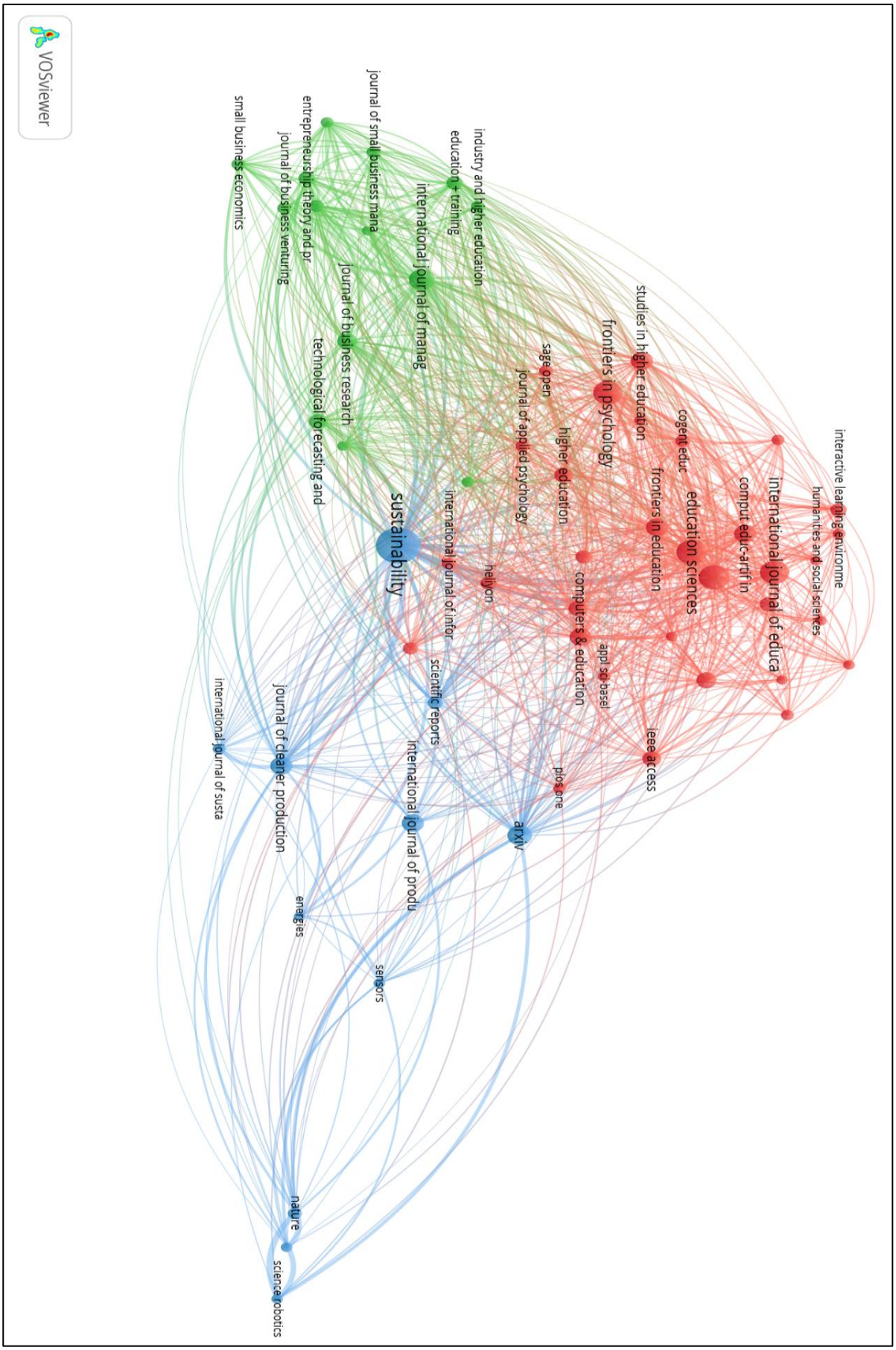


Figure 4. Network Map and cluster

3.3 Influential Documents and Author Contributions

Citation and author productivity analyses were conducted to identify the key documents and scholars shaping the development of AI-driven experiential entrepreneurship education. Using a minimum threshold of five citations, 52 documents were identified, with the ten most cited shown in in Table 2.

Author	Source	Citations
Tao (2019)	ENGINEERING-PRC	879
Abuladze (2024)	Journal of Cleaner Production	286
Broo (2022)	Journal of Industrial Information Integration	233
Ratten (2021)	The International Journal of Management Education	210
Salinas-Navarro (2024b)	Education Sciences	86
Eri (2021)	Journal of University Teaching & Learning Practice	69
Gruenhagen (2024)	Computers and Education: Artificial Intelligence	58
Jardim (2021)	Education Sciences	54
Morris (2021)	Education + Training	49
Kofinas (2025)	British Journal of Educational Technology	45

Table 2. Top Highly Cited Documents (2016-2026).

The most cited contribution is Tao (2019), reflecting the relevance of digital twin and simulation-based thinking to technology-enabled learning environments. Other influential contributions, including Ratten (2021), Morris (2021), Jardim (2021), Gruenhagen (2024), Salinas-Navarro (2024b) and Kofinas (2025), illustrate the field's movement from broader digital and experiential learning debates toward generative AI, educational technology, entrepreneurial skill development and assessment design.

Author productivity was examined using minimum threshold of two documents and five citations producing a focused group of 13 authors(Table 3). Productivity remains relatively dispersed, with only a small number of authors contributing more than two publications. Salinas-Navarro, Wang, Khlaif, Li and Vilalta-Perdomo appear as recurring contributors, while others show high citation influence through fewer publications. This indicates that the field remians emerging, with influence distributed across both prolific contributors and individual high-impact studies rather than being dominated by a small, consolidated group of scholars.

Author	Studies	Total Citations
Salinas-Navarro, De	4	131
Wang, Y	4	47
Khlaif, Zn	3	37
Li, Y	3	5
Vilalta-Perdomo, E	3	124
Ayyoub, A	2	5
Chen, J	2	31
Daher, W	2	5
Hamamra, B	2	20
Hmoud, M	2	5
Michel-Villarreal, R	2	123
Montesinos, L	2	123
Wang, L	2	879

Table 3. Top Performing Authors ranked by publication productivity (2016-2026).

3.4 Conceptual Structure via Co-Word Analysis

To identify the main conceptual themes within the corpus, a keyword co-occurrence analysis was conducted using "All Keywords", including author keywords and KeyWords Plus. Applying a minimum occurrence threshold of five, 32 keywords were organised by VOSviewer into five thematic clusters. These clusters are presented in Figure 5 and summarised in Table 4.The thematic labels and primary thematic pillars reported in Table 4 were assigned interpretively based on the dominant and conceptually related keywords within each VOSviewer generated cluster.

The first cluster focuses on behavioural competency, psychological resilience and entrepreneurial outcomes, including competence, self-efficacy, performance, stress and resilience. The second captures AI integration within higher education, including artificial intelligence, generative AI, ChatGPT, academic integrity and AI literacy. The third reflects socio-technical adaptation through digital transformation, innovation, skills, technology and acceptance. The fourth connects experiential learning with crisis-driven and sustainability-oriented themes, including COVID-19, sustainability and the Sustainable Development Goals. The fifth is more future-oriented, linking students, design, educational innovation and the future of learning. Together, these clusters suggest that the field is not only concerned with the adoption of AI tools, but also with broader questions of competency development, responsible AI use, experiential pedagogy, sustainability and student-centred educational design.

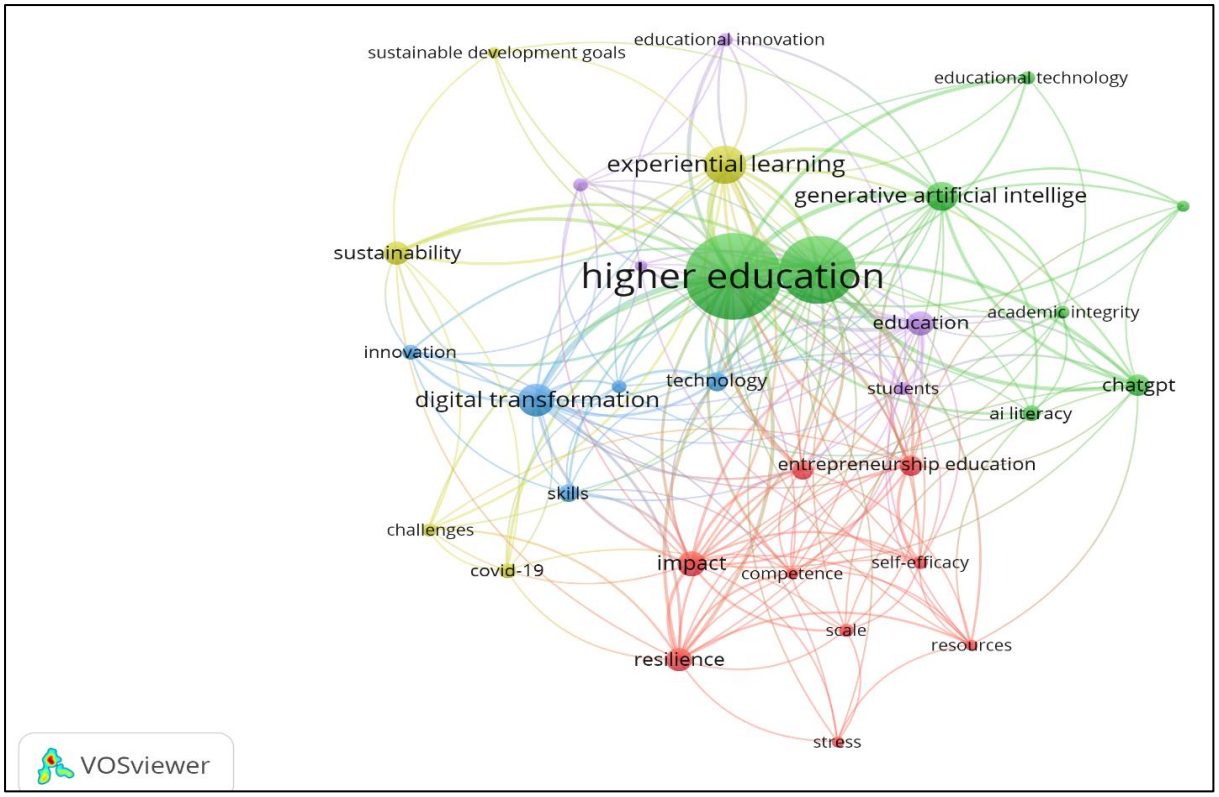


Figure 5. Keyword co-occurrence network map based on entrepreneurship education and digital disruption research

Cluster	Primary Thematic Pillar	Key Fundamental Nodes
Cluster 1 (Red)	Behavioural Competency, Psychological Resilience, & Entrepreneurial Outcomes	*Competence, Entrepreneurship Education, Impact, Performance, Resilience, Resources, Scale, Self-Efficacy, Stress*
Cluster 2 (Green)	Higher Education Ecosystems, AI Integration, & Academic Integrity	*Academic Integrity, AI Literacy, Artificial Intelligence, ChatGPT, Educational Technology, Generative Artificial Intelligence, Higher Education, Structural Equation Modeling*
Cluster 3 (Blue)	Socio-Technical Adaptation, Digital Transformation, & Innovation	*Acceptance, Digital Transformation, Innovation, Skills, Technology*
Cluster 4 (Yellow)	Crisis-Driven Pedagogy, Experiential Learning, & Global Sustainability	*Challenges, Covid-19, Experiential Learning, Sustainability, Sustainable Development Goals*
Cluster 5 (Purple)	Prospective Instructional Design & Student-Centric Evolution	*Design, Education, Educational Innovation, Future, Students*

Table 4. Conceptual cluster distribution based on keyword co-occurrence (O≥5).

3.5 Thematic Evolution and Overlay Analysis

Overlay visualisation adds a temporal dimension by mapping keywords according to their Average Publication Year (APY). As shown in Figure 6, the overlay range is concentrated between 2023.5 and 2025.5. this narrower range reflects the concentration of high-frequency keywords during the recent growth, particularly in the Algorithmic Integration Era.

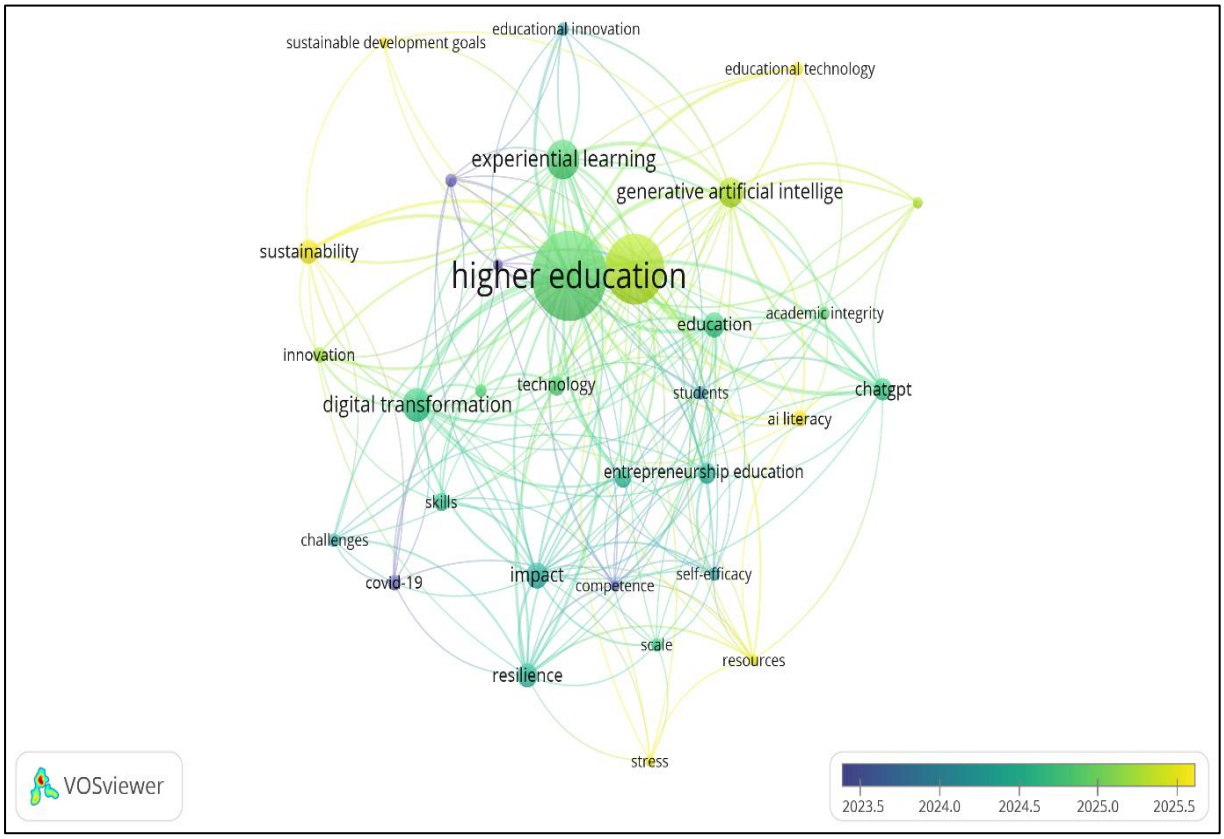


Figure 6. Temporal overlay visualisation map of keyword co-occurrence (2023.5-2025.5).

The visual pattern in indicates three broad movements. First, the **Baseline Transition** around 2023.5 is associated with terms such as COVID-19, design and future, reflecting pamdemic related disruption and reconsideration of higher education and entrepreneurial learning Second, the **Institutional Integration Phase** around 2024.5 is anchored by higher education and artificial intelligence, indicating that AI had become a more central concern within institutional and pedagogical debates. Third, the **Frontier Phase** around 2025.5 is represented by educational technology and AI literacy, suggesting a shift toward student capability, responsible use and the development of functional AI literacy.

Overall, the overlay analysis conceptual movement of the field from crisis-driven digital adaptation toward AI-centred educational redesign, reinforcing the need for a research roadmap focused on AI literacy, experiential learning design and student preparedness for digitally disrupted entrepreneurial environments.

4. Discussion and Research Roadmap

The findings show that AI-driven experiential learning in entrepreneurship education has evolved over the last decade. The results suggest an emergent domain shaped by three overlapping developments: the digital transformation of higher education, the growing

importance of experiential and work-based learning, and the disruptive acceleration of AI in entrepreneurial practice and pedagogy. Publication, co-citation and keyword patterns indicate that the field has become increasingly active during 2024–2026, reflecting growing concern with preparing students for entrepreneurial activity in uncertain, technologically mediated and precarious environments.

4.1 From digital transformation to AI-driven entrepreneurship education

The publication trajectory suggests that AI-driven experiential entrepreneurship education has shifted from a marginal topic into increasingly active research area. Limited output before 2021 indicates that entrepreneurship education, digital transformation and experiential learning had not yet formed a coherent intersection. Growth after the COVID-19 disruption and the sharp expansion during 2024–2026 indicate that AI is treated as a force reshaping entrepreneurial learning rather than merely supporting digital delivery.

This shift marks an important pedagogical transition. AI is it is increasingly linked to how students identify opportunities, test assumptions, simulate markets, receive feedback and reflect on entrepreneurial decisions. . At the same time, the source performance results show that this conversation remains distributed across education, management learning, digital technology and sustainability-oriented journals, reinforcing both the interdisciplinary nature of the field and the need for stronger integration between AI, entrepreneurship education and experiential.

4.2 Intellectual structure: a triadic knowledge base

The journal co-citation analysis revealed a triadic intellectual structure built around educational technology and digital pedagogy; business, entrepreneurship education and management training; and sustainability, open science and multidisciplinary transformation. This indicates that AI-driven experiential entrepreneurship education is shaped by the interaction of technological infrastructure, entrepreneurial learning theory and wider socio-technical challenges.

Educational technology explains how AI-enabled systems can be designed, deployed and evaluated. Entrepreneurship and management education clarify why experiential, opportunity-based and action-oriented learning remains central while sustainability and multidisciplinary transformation explain the broader conditions that entrepreneurship education must respond to. The co-citation structure therefore suggests that the future development depends on stronger integration across these knowledge bases.

This is particularly relevant to experiential and precarious perspectives. If entrepreneurship education is expected to prepare students for uncertain labour markets, digital gig work and unstable entrepreneurial environments, AI cannot be treated only as a technical tool. Future research must examine how AI-enabled learning supports entrepreneurial judgment, resilience, ethical decision-making and adaptive action under uncertainty. The current intellectual structure offers a starting point for this conversation, but the bibliometric evidence suggests that these foundations still need to be integrated into a more coherent research programme.

4.3 Thematic roadmap of the field

The keyword co-occurrence analysis provides the conceptual basis for the research roadmap. The five thematic clusters show that the field is developing around behavioural competencies and entrepreneurial outcomes, higher education ecosystems and AI integration, socio-technical adaptation and digital transformation, crisis-driven experiential learning and sustainability, and student-centred instructional design. Together, these clusters indicate that AI-driven

experiential entrepreneurship education is moving beyond tool adoption toward a broader concern with competencies, responsible use, institutional adaptation and learning design.

The behavioural competency cluster highlights the importance of self-efficacy, resilience, stress, resources and performance. This suggests that future research should examine how AI-supported learning affects not only technical competencies, but also students' confidence, resilience and ability to act under uncertainty. Similarly, the higher education and AI integration cluster shows that academic integrity, AI literacy, ChatGPT and generative AI are now central concerns. This points to the need for a more specific understanding of entrepreneurial AI literacy, where students learn to use AI critically for opportunity recognition, market validation, customer discovery, prototyping and reflective learning.

The socio-technical adaptation cluster indicates that innovation, skills, acceptance and digital transformation remain important for understanding how students, educators and institutions respond to AI-enabled entrepreneurship education. The crisis-driven experiential learning and sustainability cluster places entrepreneurship education within wider disruptions, including COVID-19, sustainability challenges and the Sustainable Development Goals. This reinforces the need to connect experiential learning with precarious contexts, including gig work, informal entrepreneurship, resource constraints and unstable labour-market conditions.

Finally, the student-centred instructional design cluster points toward curriculum architecture, assessment design and student experience as key areas for future development. AI can support reflective portfolios, simulations, live briefs, entrepreneurial labs and work-based learning tasks, as well as opportunity identification and market analysis. However, these designs must preserve experimentation, reflection, uncertainty and student agency, consistent with recent evidence that AI-supported learning is more effective when pedagogical design balances structure with learner autonomy (Quamina et al., 2026). This also requires clear guidance on responsible AI use, academic integrity and the critical evaluation of AI-generated outputs to reduce excessive dependence on automated tools. Taken together, these thematic developments suggest that the significance of AI for entrepreneurship education extends beyond technological adoption. For entrepreneurship education theory, they highlight the need to understand AI as part of the experiential learning process through which entrepreneurial judgement, experimentation and reflection are developed. For practice, they suggest that educators should design AI-supported learning activities that retain student agency, critical evaluation and engagement with uncertainty, rather than allowing the technology to replace these core elements of entrepreneurial learning. The following section translates these thematic insights into a more focused bibliometric research roadmap.

4.4 Research roadmap

The bibliometric findings point to six interconnected directions for future research. the convergence between AI, experiential learning, entrepreneurship education and precarious global contexts.

First, future studies should develop a clearer theoretical understanding of AI-enabled experiential entrepreneurship education. The rapid growth during the 2024–2026 period, contrasts with the co-citation structure still distributed across educational technology, entrepreneurship education, management learning, and sustainability literatures. This fragmentation suggests the need for integrative conceptual models explaining how AI reshapes entrepreneurial learning rather than treating AI as a technical add-on.

Second, greater attention should be given to entrepreneurial AI literacy. Although AI literacy and educational technology are emerging themes, their meaning within entrepreneurship education remains underdeveloped. Future research should examine how students to use AI critically for opportunity recognition, market validation, customer discovery, prototyping, venture planning, and entrepreneurial decision-making.

Third, further research is needed on the behavioural and psychological dimensions of AI-supported entrepreneurial learning. The keyword cluster linking self-efficacy, resilience, stress, performance, competence, and resources suggests that future studies should examine whether AI-supported experiential learning strengthens students' entrepreneurial confidence, resilience and uncertainty management, or reduces students' exposure to ambiguity, failure and real-world complexity.

Fourth, future research should investigate the design of AI-supported experiential learning environments. The presence of experiential learning, design, students, educational innovation and future in the keyword structure indicates the need for stronger pedagogical design research. This includes studies on AI-assisted simulations, venture labs, live briefs, reflective portfolios, pitch development, customer discovery tasks and work-based learning activities. Such studies should assess not only whether AI improves efficiency, but whether it enhances the quality of entrepreneurial learning, reflection and action.

Fifth, future research should place precarity more centrally within entrepreneurship education. Although the corpus engages with resilience, crisis, COVID-19, digital transformation and sustainability, precarious entrepreneurial contexts remain underdeveloped. Future studies should examine how AI-mediated entrepreneurship education prepares students for algorithmic labour markets, gig work, informal entrepreneurship, resource-constrained environments and unstable economic conditions. The international distribution of the literature also suggests the need for greater comparative research across national contexts, as differences in digital infrastructure, institutional resources, educational systems and labour-market conditions may shape how AI-supported entrepreneurship education is designed and experienced.

Finally, future research should strengthen the connection between AI-driven entrepreneurship education, sustainability and responsible assessment. The co-citation structure highlights sustainability and multidisciplinary transformation, while the keyword analysis links sustainability, SDGs, academic integrity and generative AI. Future work should therefore examine how AI-enabled experiential learning can support sustainable entrepreneurial thinking while addressing ethical risks, assessment integrity, bias, over-reliance and student agency. To provide an integrated synthesis of these findings, Figure 7 presents a visual roadmap of the field's development and future direction. The roadmap brings together four dimensions identified through the bibliometric analysis: the temporal evolution of entrepreneurship education from the pre-disruptive stage to the Algorithmic Integration Era; the three intellectual foundations underpinning the field; the five current thematic areas identified through co-word analysis; and the future research directions emerging from the gaps identified in the literature. In this way, the figure complements Table 5 by showing how the field has evolved, where current research is concentrated and how future research can extend these emerging areas.

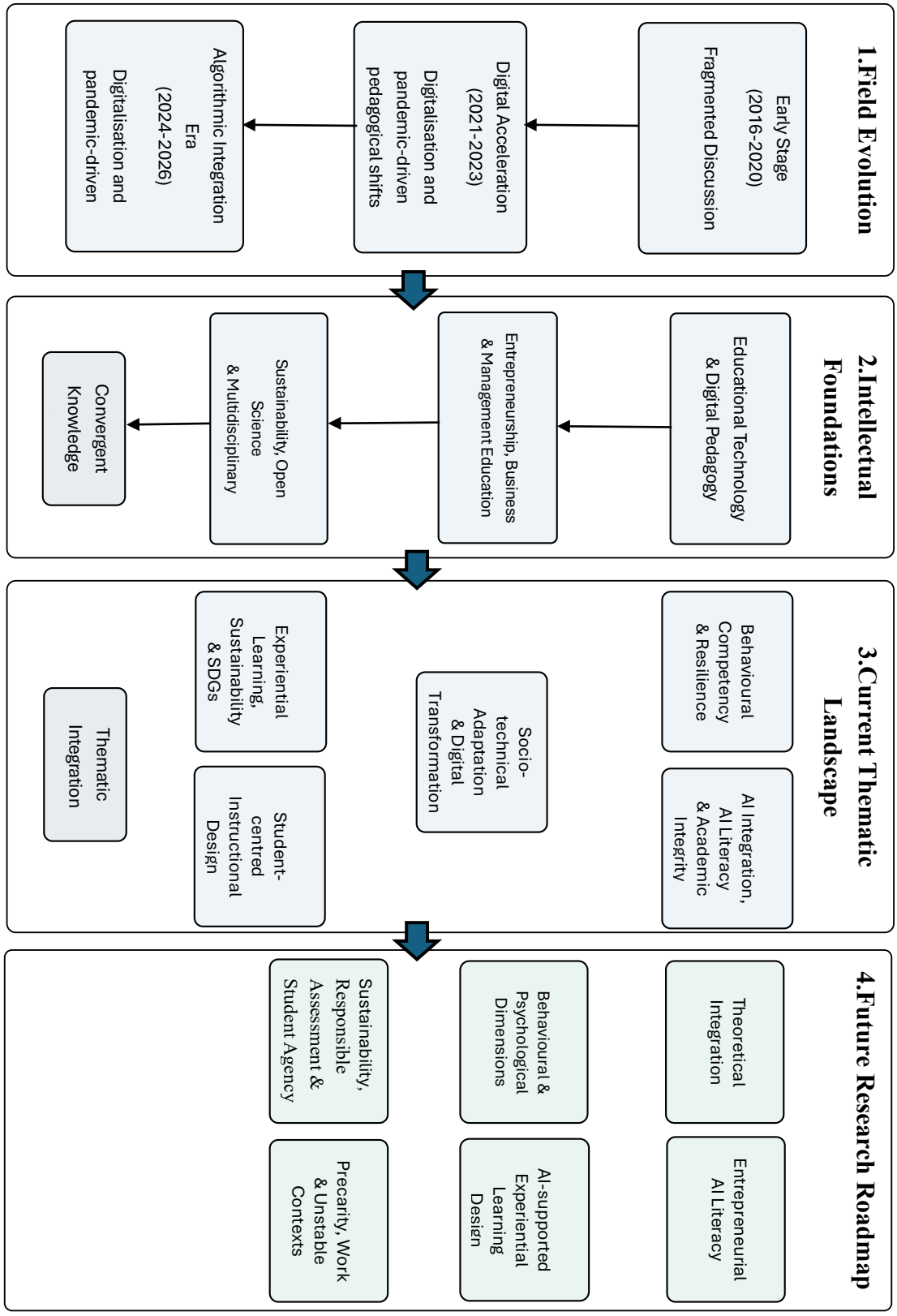


Figure 7: Integrated research roadmap for AI-driven experiential entrepreneurship education.

Table 5 summarises the proposed roadmap by linking the bibliometric evidence to emerging gaps and future research directions.

Bibliometric evidence	Emerging research gap	Future research direction
Publication growth concentrated in 2024–2026	The field is growing rapidly but remains theoretically fragmented	Develop conceptual models explaining how AI reshapes experiential entrepreneurship education
AI literacy and educational technology appear as emerging themes in the overlay map	AI literacy is discussed broadly but not yet sufficiently contextualised for entrepreneurship education	Examine entrepreneurial AI literacy in relation to opportunity recognition, venture validation, creativity and decision-making
Keyword cluster links self-efficacy, resilience, stress, performance and resources	Limited understanding of how AI affects psychological and behavioural dimensions of entrepreneurial learning	Investigate how AI-supported experiential learning influences resilience, entrepreneurial confidence and uncertainty management
Co-citation map shows separation between educational technology, entrepreneurship education and sustainability literatures	The field remains distributed across separate intellectual traditions	Develop studies connecting AI pedagogy, entrepreneurship learning and sustainable/precarious contexts
Experiential learning appears alongside crisis, COVID-19, sustainability and SDGs	Experiential learning is not yet fully linked to precarious and unstable labour-market conditions	Explore AI-enabled experiential learning for gig work, informal entrepreneurship, resource-constrained settings and Global South contexts
Academic integrity, ChatGPT and generative AI appear as central themes	Assessment debates risk focusing mainly on misconduct rather than learning design	Examine authentic assessment models that use AI responsibly while preserving reflection, uncertainty and student agency

Table 5. Research roadmap for AI-driven experiential entrepreneurship education

5.Conclusion

The findings indicate that AI-driven experiential learning in entrepreneurship education has moved from a marginal research area to a rapidly expanding field, particularly during the 2024–2026 period. While early studies focused mainly on digital transformation and technology-supported learning, growing attention to generative AI, AI literacy and educational technology has shifted attention toward how entrepreneurial learning can be redesigned for more uncertain, data-driven and precarious environments.

The bibliometric results indicate that this field is shaped by three interconnected knowledge bases: educational technology and digital pedagogy; entrepreneurship, business and management education; and sustainability-oriented transformation. This suggests that AI in entrepreneurship education should not be treated merely as a technical enhancement, but as part of a broader pedagogical shift involving experiential learning, student agency, responsible assessment, resilience and labour-market uncertainty.

The proposed research roadmap identifies priorities for developing more adaptive, experiential and responsible AI-supported approaches to entrepreneurship education. While the study is bounded by its Web of Science corpus, English-language publications and citation-based indicators, it provides a timely overview of how AI is reshaping the future direction of entrepreneurship education in higher education.

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