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RESEARCH

Extending the about–for–through tradition for AI-enabled entrepreneurship education: the AI-enabled entrepreneurial learning progression framework

Heather Bell[1] · **Robin Bell**[2]

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Abstract

Artificial intelligence (AI) is increasingly embedded within entrepreneurial practice, reshaping opportunity recognition, innovation processes, and venture-level decision-making. This transformation creates a clear need for entrepreneurship education (EE) to adopt theoretically coherent and developmentally structured approaches to AI integration. Although scholarship recognises the growing importance of AI-related knowledge, applied integration, and responsible judgement, integrative frameworks explaining how these capabilities can be progressively cultivated within EE remain limited. This paper addresses that gap by developing the AI-Enabled Entrepreneurial Learning Progression Framework. Building on the established about–for–through tradition, the framework reconceptualises AI integration as a staged capability-development process rather than a discrete curricular addition. It articulates how AI capability can be systematically developed from conceptual literacy and analytical understanding to applied integration and evaluative judgement, and ultimately to entrepreneurial capability, identity formation, and responsible agency within AI-enabled venture contexts. By aligning learning purpose, learning development, pedagogical orientation, AI positioning, curriculum focus, teaching activities, and assessment across stages, the framework advances a theory-building account. It explains how AI reshapes the developmental logic of EE. It provides a structured foundation for curriculum design and assessment alignment and establishes a platform for future empirical research on AI-enabled entrepreneurial capability formation.

Keywords Artificial intelligence · Entrepreneurship education · Teaching · Educational philosophy · Educational practice · Framework

✉ Robin Bell
r.bell@worc.ac.uk

[1] Lycoming College, Williamsport, USA

[2] Worcester Business School, University of Worcester, Worcester, UK

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Introduction

Artificial intelligence (AI) is increasingly embedded within entrepreneurial practice, reshaping how ventures are conceived, developed, and managed. AI-enabled systems lower barriers to entry in certain sectors and enable data-driven business models grounded in algorithmic capabilities and digital infrastructures (Uriarte et al., 2026). AI expands the opportunity landscape while intensifying competitive pressures for firms that do not adopt such technologies. Research suggests that AI adoption enhances productivity, decision speed, and analytical capability, strengthening competitive positioning in dynamic markets (Short & Short, 2023).

AI is also transforming innovation within entrepreneurial firms. Its application in idea generation, design optimisation, rapid prototyping, and product personalisation has prompted reconfiguration of research and development processes (Roberts & Candi, 2024). AI integration has been associated with improved innovation performance through accelerated experimentation and iteration. Big data analytics enable ventures to learn rapidly from customer and product usage data, supporting faster business model refinement and market responsiveness (Lehrer et al., 2018; Liu, 2019). These developments reshape how entrepreneurs recognise, evaluate, and exploit innovation opportunities (Alhassan et al., 2025).

Recent advances in generative AI extend these transformations. Such systems support ideation, communication, scaling, and market engagement (Chalmers et al., 2021; Short & Short, 2023), augmenting creative exploration while enhancing analytical reasoning in decision-making (Townsend & Hunt, 2019; Korzynski et al., 2023). AI is therefore implicated not only in operational efficiency but also in opportunity framing and strategic direction.

AI integration also reshapes managerial and organisational dynamics within entrepreneurial ventures. Adoption has implications for accountability and coordination mechanisms (Keegan & Meijerink, 2025), shifting managerial roles toward oversight and ethical governance of AI-supported processes (Gong et al., 2025). AI-enabled systems influence recruitment, monitoring, performance management, and strategic forecasting (Nawaz et al., 2024; Vincent, 2021), redefining the capabilities required of entrepreneurs (Short & Short, 2023).

The expanding role of AI in entrepreneurial practice has direct implications for entrepreneurship education (EE). As AI becomes increasingly embedded in opportunity recognition, innovation processes, and venture management, developing a robust understanding of AI systems and their application is emerging as an important dimension of entrepreneurial competence (Bell & Bell, 2023; Short & Short, 2023). Recent scholarship in EE recognises that generative and data-driven AI systems are reshaping the skills, assessment practices, and learning outcomes associated with entrepreneurial training, and calls for more systematic pedagogical responses rather than ad hoc classroom experimentation (Winkler et al., 2023; Chen et al., 2024).

For EE, this raises foundational questions about what knowledge, skills, and judgement future entrepreneurs require in AI-enabled environments. Beyond basic awareness, learners may need to develop data literacy, the capacity to utilise and critically interpret AI outputs, and an understanding of governance, bias, and accountability considerations associated with AI-supported decision-making (Short & Short,

2023; Dwivedi 2025). Literature has further emphasised that generative AI represents a field-level disruption requiring systematic pedagogical innovation rather than incremental adjustment or isolated experimentation (Winkler et al., 2023). However, recent reviews indicate that although interest in AI integration within EE is increasing, coherent theoretical frameworks for structuring AI-related capability development remain limited (Chen et al., 2024; Yu et al., 2025) and conceptually fragmented (Elsa et al., 2026). This paper addresses this lacuna by developing a structured pedagogical framework for staging AI-enabled entrepreneurial capability development, articulating how such capability can be progressively developed within EE. It responds to calls for clearer structuring of how AI-related knowledge, applied integration, and responsible judgement can be systematically developed within EE (Bell & Bell, 2023; Short & Short, 2023).

This paper develops the AI-Enabled Entrepreneurial Learning Progression Framework to articulate how AI-enabled entrepreneurial capability can be coherently developed across the established "about", "for", and "through" stages of EE. The framework builds on this well-established foundation and clarifies how AI integration deepens progressively, moving from conceptual literacy and analytical understanding (about) to applied integration and evaluative judgement (for), and ultimately to capability, identity, and responsible agency (through). It provides a structured basis for curriculum sequencing, assessment alignment, and staged capability development. By foregrounding progression rather than tool adoption, the framework advances a coherent theoretical foundation for integrating AI within EE and establishes a platform for future empirical research.

Foundations

Teaching about-for-through entrepreneurship

The distinction between learning about, for, and through entrepreneurship is well established within EE scholarship as a way of differentiating the purposes and orientations of entrepreneurial learning. First articulated by Jamieson (1984) and subsequently developed within higher education contexts (Taatila, 2010), the typology distinguishes between conceptual knowledge development, competence formation, and experiential engagement in venture activity (Pittaway & Cope, 2007). It has informed debates concerning entrepreneurship as content versus entrepreneurship as practice (Neck & Greene, 2011) and has been used to clarify instructional priorities and learning objectives (Kakouris & Liargovas, 2021). As such, it provides a lens for curriculum design and constructive alignment between learning outcomes, pedagogy, and assessment (Hannon, 2006; Bell, 2021), and remains reflected in policy guidance (QAA, 2018).

Learning about entrepreneurship emphasises conceptual and analytical understanding of entrepreneurial phenomena, focusing on theoretical foundations and models that enable students to interpret venture creation and innovation processes (Kakouris & Liargovas, 2021). This orientation aligns with scholarship distinguishing knowledge-based EE from action-based and experiential approaches (Pittaway

& Cope, 2007). Pedagogically, it is associated with analytically oriented teaching methods, and assessment prioritises understanding and application of entrepreneurial theory (Hannon, 2006).

Learning for entrepreneurship shifts emphasis toward the development of entrepreneurial competences required for action, including opportunity recognition, creativity, planning, and resource mobilisation (Bell & Bell, 2020; Kakouris & Liargovas, 2021). Reflecting competence-based and method-driven perspectives (Neck & Greene, 2011), it typically incorporates active and applied learning approaches. Assessment focuses on the demonstration of applied performance and judgement (Nabi et al., 2017).

Learning through entrepreneurship represents immersive engagement in venture creation and entrepreneurial projects. Grounded in experiential learning theory (Kolb, 2014) it views entrepreneurial learning as reflective and adaptive (Rae, 2005), and emphasises learning through action, iteration, and reflection (Bell & Bell, 2020). Assessment commonly centres on reflective evaluation of entrepreneurial processes rather than solely venture outcomes (Kauppinen et al., 2019).

These pedagogical orientations within the typology are generally treated as complementary rather than strictly hierarchical. Programmes frequently combine conceptual instruction, competence development, and experiential engagement in varying configurations (Pittaway & Cope, 2007; Nabi et al., 2017), and the typology has primarily functioned as an organising framework rather than a prescriptive developmental sequence (Kakouris & Liargovas, 2021). While broadly compatible with cognitive development frameworks such as Bloom's taxonomy (Bloom et al, 1956; Anderson et al., 2001), the about–for–through distinction has not typically been framed as a formal progression (Bell, 2023). More broadly, educational technologies in EE are frequently adopted without coherent pedagogical structuring (Chen et al., 2021). This lack of coherence reflects broader ambiguity in how EE is framed across policy and practice contexts, where evolving and often competing definitions of purpose continue to shape pedagogical approaches (Bell & Bell, 2026). This lack of coherence also reflects wider concerns about alignment between higher education provision and the competencies required in contemporary work contexts, where curricula must increasingly respond to employer expectations and complex, collaborative environments (Prouska et al., 2026).

The increasing integration of AI into entrepreneurial practice does not render this distinction obsolete. Rather, it reshapes the substantive demands associated with each orientation. Research demonstrates that AI influences opportunity recognition, innovation processes, and entrepreneurial decision-making (Chalmers et al., 2021), and EE scholarship has begun to examine the pedagogical implications of these developments (Bell & Bell, 2023; Winkler et al., 2023). Reviews further indicate that while experimentation with AI tools is increasing, coherent structuring of AI-related capability development remains limited (Chen et al., 2024).

As AI alters how ventures are conceived and developed, it correspondingly alters what must be understood, practised, and experienced within EE. The question therefore becomes how AI-related knowledge, applied integration, and responsible judgement should be articulated within each of these modes. Clarifying these demands

provides the foundation for articulating how AI-enabled capability can be coherently developed across the about, for, and through stages of EE.

AI-specific learning demands in entrepreneurship education

Conceptual AI literacy

The integration of AI into entrepreneurial practice introduces new conceptual learning demands within EE. Beyond awareness of AI tools, students require foundational understanding of how AI systems function, how they are trained, and the limitations inherent in probabilistic and data-dependent outputs. AI literacy has been conceptualised as a set of competencies enabling individuals to interpret, evaluate, and communicate about AI systems rather than treating them as opaque technologies (Long & Magerko, 2020). Within entrepreneurial contexts, this includes understanding how AI shapes opportunity recognition, market analysis, and venture development processes (Chalmers et al., 2021).

EE scholarship further indicates that generative AI reshapes curriculum content and assessment practices, requiring learners to engage with AI not merely as a productivity tool but as a phenomenon influencing entrepreneurial cognition and value creation (Bell & Bell, 2023). Conceptual AI literacy therefore encompasses recognition of model limitations, hallucinations, data dependencies, and contextual variability in outputs. Fox et al. (2024) emphasise that both instructors and learners must understand how AI systems behave within learning tasks, including role drift, output variability, and prompt sensitivity. Such literacy forms the epistemic foundation upon which more advanced AI-enabled entrepreneurial competence can be developed.

Applied AI integration and judgement

In addition to conceptual literacy, EE must address the applied integration of AI within entrepreneurial activity. AI systems increasingly support tasks associated with ideation, innovation management, scaling, and decision-making in new ventures (Chalmers et al., 2021). As AI becomes embedded within entrepreneurial workflows, students must learn not only how to operate AI technologies, but how to integrate them strategically into entrepreneurial processes.

This applied dimension requires evaluative judgement. AI-generated outputs are probabilistic and contingent upon training data, necessitating contextual interpretation and human oversight. Research on AI-assisted strategic decision-making demonstrates that the value of AI often lies in augmentation rather than substitution, underscoring the importance of domain expertise and critical evaluation in interpreting AI-supported insights (Cristofaro, 2026; Raisch & Krakowski, 2021). Within EE, learners must therefore develop the capacity to validate outputs, determine when AI support is appropriate, and exercise strategic discretion.

Recent work in EE further reinforces this need for structured oversight. By conceptualising AI as a role-bearing participant within entrepreneurial learning tasks, Fox et al. (2024) show that AI integration requires explicit role definition and monitoring, as systems may drift from assigned functions or generate misleading outputs.

Learners remain accountable for AI-supported decisions, highlighting that applied AI competence includes responsibility as well as technical skill. More broadly, generative AI has been identified as a development requiring systematic pedagogical innovation rather than incremental tool adoption (Winkler et al., 2023), while reviews indicate limited coherence in structuring such capability development (Chen et al., 2024). Applied integration and evaluative judgement therefore constitute core learning demands that must be intentionally designed within entrepreneurship curricula, as generative AI incorporation has been shown to strengthen opportunity exploration and exploitation, which in turn mediate effects on entrepreneurial attitudes, intentions, and behaviour (Le et al., 2026).

Responsible and reflexive AI governance

A third dimension of AI-related learning concerns governance, accountability, and reflexive responsibility within entrepreneurial contexts. AI systems introduce challenges relating to bias, transparency, misinformation, and decision authority that extend beyond technical proficiency (Mittelstadt et al., 2016; Dwivedi et al., 2023). Foundational work in responsible AI emphasises principles such as explicability, fairness, and accountability when algorithmic systems influence consequential decisions (Floridi & Cowls, 2019). As AI becomes embedded within opportunity recognition, innovation management, and strategic decision-making (Chalmers et al., 2021), these governance considerations intersect directly with stakeholder accountability, regulatory compliance, and reputational risk in venture contexts.

Research on AI-supported organisational decision-making further demonstrates that while AI may augment analytical capacity, authority and responsibility remain with human actors (Raisch & Krakowski, 2021; Shrestha et al., 2019). In entrepreneurial settings, founders and managers therefore retain accountability for AI-embedded judgements, including output validation, bias mitigation, and oversight of automated processes. EE scholarship similarly indicates that when AI systems participate in learning tasks, authority structures and accountability relationships are reshaped, requiring explicit monitoring and transparent governance (Fox et al., 2024; Holmes et al., 2022).

Responsible and reflexive AI governance thus represents a central dimension of AI-enabled entrepreneurial capability. Preparing learners to deploy AI effectively must be accompanied by the capacity to exercise ethical and strategic judgement, recognise overreliance risks, and retain accountability for AI-embedded entrepreneurial decisions.

The analysis of AI-specific learning demands indicates that conceptual literacy, applied integration and judgement, and responsible governance constitute interconnected dimensions of entrepreneurial capability in AI-enabled environments. The question is not whether these capabilities are necessary, but how they should be pedagogically structured. The established about–for–through distinction provides a durable foundation for this structuring. Reinterpreting these orientations in light of AI-enabled practice allows a clearer articulation of how AI capability may deepen progressively from conceptual understanding to applied integration, to reflexive responsibility within entrepreneurial activity.

The framework developed in this paper is a conceptual and integrative synthesis rather than an empirical model. It draws on the established about–for–through tradition, emerging literature on AI in EE, and relevant learning theory perspectives. These strands are aligned to articulate how AI-related knowledge, applied integration, and responsible judgement may be progressively developed across stages, with learning purpose, pedagogy, AI positioning, and assessment structured accordingly.

Reinterpreting about–for–through in AI-enabled entrepreneurship education

Building on the established distinction between learning about, for, and through entrepreneurship (Pittaway & Cope, 2007), this section reinterprets these orientations in light of AI-enabled entrepreneurial practice. As AI becomes embedded within opportunity recognition, innovation processes, and entrepreneurial decision-making (Chalmers et al., 2021), it reshapes the substantive demands associated with each mode by altering what must be understood, practised, and governed within venture contexts.

In AI-enabled environments, learning about entrepreneurship extends to conceptual literacy and analytical understanding of how AI generates and shapes entrepreneurial information. Learning for entrepreneurship requires applied integration of AI tools with evaluative judgement. Learning through entrepreneurship also evolves as AI becomes embedded within venture activity, demanding entrepreneurial capability, identity formation, and responsible agency within AI-enabled venture contexts.

Although traditionally presented as complementary orientations, the about–for–through distinction is compatible with cognitive development frameworks that differentiate between knowledge acquisition and higher-order processes such as application, evaluation, and creation (Bloom et al, 1956; Anderson et al., 2001). The integration of AI enables these orientations to be articulated as a structured progression through which capability is developed from conceptual literacy and analytical understanding to applied integration and evaluative judgement, and ultimately to entrepreneurial capability, identity formation, and responsible agency within AI-enabled venture contexts.

While the framework is presented as a staged progression, this should not be interpreted as a strictly linear or sequential process. In practice, learning may be iterative and recursive, with learners moving between stages as their understanding develops and as they encounter new contexts and challenges (Kolb, 2014; Schön, 1983). For example, engagement in applied or experiential tasks may prompt renewed conceptual interrogation of AI outputs, while emerging venture experiences may require revisiting earlier assumptions about AI capabilities and limitations. The staged structure reflects a developmental orientation rather than a fixed sequence, providing a coherent progression while recognising the dynamic and non-linear nature of entrepreneurial learning. Across all stages, critical engagement with AI remains central, including recognition of limitations such as bias, opacity, and risks of overreliance, which must be actively addressed through pedagogical design and reflective practice.

The stages of this progression are examined below.

Stage one: about entrepreneurship in AI-enabled contexts

Purpose of learning

The purpose of learning at the about entrepreneurship stage in AI-enabled contexts is to develop informed conceptual understanding of how AI shapes entrepreneurial phenomena. Traditionally, learning about entrepreneurship has focused on theoretical and analytical knowledge concerning venture creation, innovation, and growth processes (Pittaway & Cope, 2007). As AI becomes embedded within opportunity recognition, innovation management, and strategic decision-making (Chalmers et al., 2021), this orientation expands to include understanding how AI generates, structures, and shapes entrepreneurial information.

The objective is not operational mastery of AI tools, but the development of AI-related conceptual literacy. AI literacy refers to the capacity to interpret, evaluate, and critically engage with AI systems rather than treating them as opaque technologies (Long & Magerko, 2020). Within EE, this includes recognising how AI outputs are produced, understanding their probabilistic and data-dependent nature, and evaluating their implications for entrepreneurial reasoning (Bell & Bell, 2023). The emphasis remains epistemic: cultivating analytical comprehension and critical judgement regarding AI's role within entrepreneurial processes. Students should critically assess how AI-generated insights shape opportunity evaluation, risk assessment, and strategic reasoning, while distinguishing between algorithmic prediction and entrepreneurial judgement. This conceptual foundation enables informed evaluation and prepares learners for subsequent applied integration.

Learning development

Learning development at this stage centres on structuring conceptual understanding and analytical reasoning concerning AI-enabled entrepreneurial processes. Consistent with cognitive development frameworks that distinguish foundational knowledge from higher-order application (Bloom et al, 1956), this phase emphasises comprehension, interpretation, and critical analysis rather than practical deployment. Learners engage with AI as interpreters of systems rather than operators of tools, questioning assumptions, evaluating data sources, and recognising when AI outputs may be reliable or misleading. Structured analytical engagement with AI-generated artefacts strengthens awareness of the affordances and limits of generative systems, which require iterative prompting and human judgement (Gedeon & Huber, 2025).

EE scholarship associates learning about entrepreneurship with knowledge acquisition and analytical insight rather than experiential enactment (Pittaway & Cope, 2007). In AI-enabled contexts, this extends to understanding how algorithmic reasoning interacts with entrepreneurial cognition and decision-making (Chalmers et al., 2021). Students learn to distinguish between correlation and causation, prediction and strategic judgement, and automated output and human interpretation. Evaluative judgement begins to emerge but remains grounded in conceptual analysis, preparing learners for subsequent applied integration.

Pedagogical orientation

At the about stage in AI-enabled EE, pedagogy supports structured conceptual development and analytical reasoning. Structured instruction establishes foundational knowledge of AI systems, terminology, and the mechanisms through which outputs are generated (Bell, 2021), providing clarity for more advanced evaluative engagement.

Conceptual AI literacy requires movement beyond exposition toward guided cognitive interrogation. Cognitivist perspectives emphasise how learners organise and critically evaluate knowledge within internal frameworks (Anderson et al., 2001), and learning about entrepreneurship has long prioritised analytical understanding (Pittaway & Cope, 2007). In AI-enabled contexts, this emphasis is particularly significant, as AI-generated outputs may appear authoritative while remaining probabilistic and context-dependent. Research on AI-supported decision-making highlights risks of automation bias and overreliance when recommendations are not critically examined (Raisch & Krakowski, 2021; Shrestha et al., 2019).

Pedagogically, this stage combines structured explanation with guided analytical interrogation. Learners examine AI-supported scenarios, question assumptions, identify model limitations, and assess contextual relevance. AI outputs are treated as objects of conceptual analysis rather than instruments of venture execution, establishing the epistemic discipline required for later stages.

AI positioning and curriculum design

At the about entrepreneurship stage, AI is positioned primarily as an object of conceptual and critical inquiry rather than as a production tool. In line with constructive alignment principles (Biggs, 2012), curriculum design ensures AI-related content is explicitly connected to knowledge-oriented learning outcomes emphasising understanding and analytical interpretation. Learners examine how AI systems generate information, how outputs are shaped by training data and probabilistic reasoning, and how such systems influence opportunity recognition and strategic judgement (Chalmers et al., 2021).

The curriculum focus centres on the epistemic dimensions of AI. Students engage with questions concerning model limitations, bias, evidentiary validity, and contextual appropriateness. Rather than rehearsing entrepreneurial execution, they analyse how AI reshapes entrepreneurial cognition and strategic reasoning (Bell, 2023; Pittaway & Cope, 2007).

Teaching activities remain analytically oriented but incorporate structured engagement consistent with active learning principles (Prince, 2004). Learners critically evaluate AI-generated opportunity analyses, compare AI recommendations with human reasoning, and analyse prompt–output relationships to understand variability. Assessment aligns with knowledge-oriented outcomes and emphasises analytical reasoning and critical evaluation (Nabi et al., 2017; Pittaway & Edwards, 2012). In AI-enabled contexts, students explain how AI systems function, evaluate outputs, and assess their implications for entrepreneurial reasoning. The emphasis remains on conceptual clarity and evidence-based judgement, consolidating the epistemic

foundation upon which applied integration and evaluative judgement in Stage Two depend. This is illustrated in the application presented in Fig. 2, where learners critically evaluate AI-generated outputs rather than acting on them.

Progression from the about stage to the for stage does not require advanced technical expertise in AI development or data science. Rather, learners require a level of functional interactional competence, including prompt formulation, output interpretation, and recognition of model limitations within context. This foundational capability enables movement from conceptual analysis toward applied integration, where emphasis shifts from understanding AI to using it strategically within entrepreneurial tasks.

Stage two: for entrepreneurship in AI-enabled contexts

Purpose of learning

The purpose of learning at the for entrepreneurship stage in AI-enabled contexts is to develop the capability to integrate AI into entrepreneurial activity with informed evaluative judgement. Whereas learning about entrepreneurship cultivates conceptual understanding of AI's role in entrepreneurial processes, learning for entrepreneurship moves from interpretation to enactment, preparing students to integrate AI within entrepreneurial action through competences associated with opportunity recognition, resource mobilisation, and strategic decision-making (Neck & Greene, 2011). Competence-based approaches in EE emphasise structured engagement with practice to develop applied capability (Bell & Bell, 2020).

As AI becomes embedded within ideation, innovation processes, and venture analytics (Chalmers et al., 2021), entrepreneurial competence expands to include the strategic integration of AI within entrepreneurial workflows. This involves more than technical operation: learners must judge when AI support is appropriate, interpret probabilistic outputs in context, and incorporate AI insights into broader entrepreneurial reasoning. Research on AI-supported decision-making shows that AI systems augment rather than replace human discretion (Butsch et al., 2025; Raisch & Krakowski, 2021). Applied AI competence at this stage is therefore grounded in strategic awareness and informed human discretion within entrepreneurial activity.

Learning development

Learning development at the for entrepreneurship stage marks progression from conceptual literacy toward applied integration in AI-supported entrepreneurial contexts. Whereas the about stage establishes analytical understanding of AI systems, this phase operationalises that understanding within entrepreneurial action. In cognitive terms, emphasis shifts from comprehension toward application and evaluative judgement (Bloom et al, 1956; Anderson et al., 2001). Learners engage with AI as a tool within entrepreneurial workflows, using it to generate alternatives, test assumptions, simulate scenarios, and inform strategic choices.

EE scholarship characterises learning for entrepreneurship as competence-based and practice-oriented, grounded in structured engagement with entrepreneurial tasks

(Neck & Greene, 2011). Reviews similarly highlight applied skill development and performance-oriented learning within competence-focused approaches (Nabi et al., 2017). In AI-enabled environments, this competence includes strategic integration of AI outputs within decision processes. Students interpret AI recommendations in context, adapt outputs to entrepreneurial uncertainty, and exercise discretion in deployment.

Evaluative judgement becomes central. Reflection assumes a deliberate and structured role, consistent with experiential learning theory's emphasis on transforming experience into learning (Kolb, 2014; Rae, 2005). Learners review how AI informed their decisions, justify acceptance or modification of outputs, and critically appraise alignment between AI insight and entrepreneurial intent. In line with constructivist–acquisition orientations (Bell & Cui, 2023), understanding is constructed within scaffolded tasks while learners remain positioned as developing decision-makers rather than participants in consequential venture practice. Reflection therefore strengthens evaluative judgement within structured entrepreneurial tasks and lays groundwork for the immersive engagement of Stage Three. Applied AI capability involves integrating AI strategically within decision-making while retaining evaluative control over decision processes.

Pedagogical orientation

The pedagogical orientation at the for entrepreneurship stage shifts from structured conceptual explanation toward scaffolded applied engagement. Whereas the about stage draws primarily on behaviourist and cognitivist approaches supporting knowledge acquisition (Bell, 2021), this stage draws more strongly on constructivist traditions in which learners apply knowledge within structured problem contexts.

Constructivist theory conceptualises learning as active meaning-making through engagement with realistic problems (Jonassen, 1999; Mueller & Anderson, 2014). In EE, such approaches are associated with competence development through rehearsal of entrepreneurial tasks (Neck & Greene, 2011). AI is embedded within guided activities simulating entrepreneurial workflows, enabling students to generate alternative framings, stress-test assumptions, model scenarios, and compare strategic options.

Constructivist engagement does not imply unstructured experimentation. Research on scaffolding emphasises guided facilitation to prevent cognitive overload and superficial engagement (Hmelo-Silver et al., 2007). Educators structure tasks requiring justification of decisions, comparison of AI-generated outputs with theoretical frameworks, and articulation of reasoning behind acceptance or rejection of recommendations.

Structured reflection is embedded within scaffolded activities. Consistent with constructivist–acquisition orientations (Bell & Cui, 2023), reflection consolidates applied understanding within defined task environments. Learners articulate how AI was positioned within tasks, what assumptions shaped outputs, and how discretion was exercised. Reflection remains guided and formative, strengthening evaluative judgement within structured problem contexts rather than interrogating identity or long-term responsibility. Such scaffolded integration reflects deliberate practice and a guided cognitive apprenticeship within structured task environments (Haines,

2025). Given evidence of automation bias (Raisch & Krakowski, 2021; Shrestha et al., 2019), pedagogy incorporates structured evaluation, including comparison of multiple AI-generated outputs and justification of decisions, to position AI outputs as inputs into human deliberation rather than authoritative solutions.

AI positioning and curriculum design

At the for entrepreneurship stage, AI is positioned as a strategic tool within entrepreneurial workflows rather than solely as an object of conceptual analysis. Curriculum design shifts from examining how AI functions to engaging learners in its applied integration within structured entrepreneurial tasks. In alignment with competence-based approaches to EE (Neck & Greene, 2011), AI is embedded within opportunity evaluation, business modelling, customer analysis, venture analytics, and AI-supported planning.

Constructive alignment remains central (Biggs, 2012). Learning outcomes emphasise applied competence and evaluative discretion. Activities require learners to deploy AI within defined scenarios, interpret outputs, and justify decision pathways. The pedagogical emphasis remains on how learners integrate and interpret AI outputs rather than on the sophistication of automated material.

Teaching activities reflect competence-oriented traditions in EE (Neck & Greene, 2011) and active learning principles (Prince, 2004). AI is embedded within structured exercises such as simulations and venture modelling projects, positioning it as a tool within rehearsed entrepreneurial action. Learners generate AI-supported outputs, compare recommendations with theoretical frameworks, and adapt outputs to uncertainty. Research shows that AI outputs can shape decision processes if not deliberately framed (Fox et al., 2024) and given risks of automation bias (Raisch & Krakowski, 2021; Shrestha et al., 2019), teaching design incorporates explicit scaffolding to ensure outputs are interrogated and strategically interpreted.

Assessment aligns with competence-oriented outcomes and emphasises applied performance and evaluative judgement (Nabi et al., 2017; Pittaway & Edwards, 2012). Evaluation focuses on the quality of human judgement exercised in AI-supported decision-making rather than the sophistication of automated output (Raisch & Krakowski, 2021; Shrestha et al., 2019). This applied integration builds directly on the conceptual literacy established in Stage One and prepares learners for the consequential, identity-forming engagement characteristic of Stage Three. As shown in Fig. 2, learners begin to integrate AI into decision-making tasks while exercising evaluative judgement over how outputs are interpreted and applied.

Movement from the for stage to the through stage does not depend on increased technical sophistication in AI usage, but rather on learners' readiness to engage with AI within contexts characterised by uncertainty, consequence, and accountability. This involves the capacity to exercise judgement beyond structured tasks, to adapt AI-supported decisions in response to emergent conditions, and to assume responsibility for outcomes within entrepreneurial settings.

Stage three: through entrepreneurship in AI-enabled contexts

Purpose of learning

At the through entrepreneurship stage in AI-enabled contexts, learning shifts from applied competence toward the development of entrepreneurial capability and mindset through immersive experiential engagement. Whereas the for entrepreneurship stage emphasises structured rehearsal of AI-supported tasks, learning through entrepreneurship involves participation in venture activity where uncertainty, consequence, and ambiguity are encountered directly (Neck & Greene, 2011). Experiential EE literature characterises this stage as action-based and identity-forming, with capability emerging through participation rather than simulation (Bell & Bell, 2020). This aligns with calls for university-wide EE that cultivates the skills and dispositions required to address complex societal challenges (Reimers, 2024).

Drawing on experiential learning theory, capability develops through cycles of action and structured reflection (Kolb, 2014). Reflective engagement supports the development of judgement, resilience, and adaptive expertise in uncertain entrepreneurial environments (Rae, 2005). In AI-enabled contexts, this requires learners to navigate how AI systems influence opportunity recognition, resource allocation, and strategic direction while retaining responsibility for venture-level outcomes (Chalmers et al., 2021).

The developmental emphasis therefore moves beyond integration toward reflexive judgement under technological mediation. Although AI may augment analytical capacity, accountability for decision consequences remains with the entrepreneur (Raisch & Krakowski, 2021; Shrestha et al., 2019). The purpose of learning at this stage is thus the formation of AI-enabled entrepreneurial capability and mindset: the capacity to exercise informed discretion, adapt strategically, and assume responsibility within socio-technical venture environments. This includes developing an entrepreneurial self-conception grounded in agency and accountable decision-making within AI-embedded contexts.

Learning development

Learning development at the through stage reflects a shift from applied integration toward adaptive capability, identity formation, and responsible agency within AI-embedded practice. Whereas the for stage emphasises structured rehearsal and evaluative judgement within defined tasks, this stage involves engagement in authentic or high-consequence contexts where uncertainty and accountability are experienced directly (Neck & Greene, 2011).

Experiential entrepreneurship scholarship conceptualises capability development as emerging through cycles of action and reflection situated in lived activity (Kolb, 2014; Rae, 2005). In AI-enabled environments, capability development extends beyond task performance to include reflexive awareness of how AI shapes opportunity framing, decision pathways, and strategic outcomes (Chalmers et al., 2021). Learners must navigate not only market uncertainty but also technological uncertainty, including data validity, bias, opacity, and evolving system behaviour.

Reflection at this stage becomes situated and participation oriented. In contrast to the constructivist–acquisition orientation of Stage Two, learning through entrepreneurship reflects a participation orientation in which AI-enabled capability, identity, and agency emerge through engagement in consequential venture practice (Bell & Cui, 2023). Reflection is therefore formative as well as evaluative, prompting learners to interrogate how AI shapes decisions and how accountability is exercised.

Evaluative judgement becomes embedded within consequential action. Students move from integrating AI in structured exercises to exercising discretion where AI outputs shape venture-level decisions. Research on hybrid human–AI decision processes confirms that accountability remains with human actors (Raisch & Krakowski, 2021; Shrestha et al., 2019). Learning development therefore involves retaining strategic authority, recognising overreliance risks, and assuming responsibility for AI-embedded outcomes.

Experiential engagement also contributes to identity formation. EE research links sustained venture participation with development of entrepreneurial self-concept and mindset (Anton & Mansingh, 2025; Bell & Bell, 2020). In AI-enabled contexts, identity formation incorporates the emergence of a technologically literate and ethically reflexive entrepreneurial self, capable of integrating AI capability with responsible governance. Capability at this stage involves navigating uncertainty and sustaining accountability within AI-embedded entrepreneurial ecosystems.

Pedagogical orientation

The pedagogical orientation at the through stage is grounded in experiential, constructivist, and humanistic traditions. Whereas Stage Two emphasises scaffolded rehearsal, this phase centres on immersive engagement in authentic or near-authentic entrepreneurial activity where learning emerges through action, consequence, and reflection (Neck & Greene, 2011; Bell & Bell, 2020).

Experiential learning theory conceptualises learning as a cycle of experience, reflection, conceptualisation, and experimentation (Kolb, 2014). In AI-enabled contexts, learners deploy AI within venture activity, reflect on how outputs shape reasoning, refine strategic understanding, and adjust actions accordingly. Schön's (1983) notion of reflection-in-action highlights real-time interrogation of AI-supported judgements under ambiguity and time pressure. Where AI outputs may appear authoritative yet remain probabilistic, situated reflective judgement becomes central.

Constructivist perspectives emphasise knowledge construction through engagement with complex problems (Mueller & Anderson, 2014), while humanistic philosophy foregrounds autonomy and responsibility in self-authored decision-making (Aloni, 2002; Bell, 2022). Within AI-enabled practice, learners must not only use AI effectively but assume ownership of AI-supported decisions, reconcile technological capability with ethical considerations, and integrate technical insight with personal and societal values. Agency becomes more demanding rather than diminished by AI integration.

Pedagogically, this stage combines experiential immersion with structured reflective dialogue. Learners examine how AI shaped decisions, where bias or overreliance emerged, and how accountability was exercised. AI is positioned as a socio-technical

participant within venture practice whose influence must be critically examined. Through this orientation, learners develop AI-enabled entrepreneurial capability, identity, and responsible agency in an integrated manner.

AI positioning and curriculum design

At the through stage, AI is positioned as an embedded element of venture-level practice rather than a rehearsal tool. In contrast to Stage Two, where AI is integrated within guided tasks, this stage situates AI within authentic entrepreneurial contexts. Experiential EE literature emphasises that immersive venture engagement creates qualitatively different learning conditions from simulation, particularly where uncertainty and consequence are present (Neck & Greene, 2011). Curriculum design centres on sustained venture activity in which AI forms part of the lived decision environment (Bell & Bell, 2020).

The curriculum focus extends beyond applied competence to integration of AI-enabled capability with identity and responsibility. Learners deploy AI in customer discovery, strategic pivots, operational design, and stakeholder communication, while articulating how they position themselves as accountable decision-makers (Rae, 2005). Teaching activities may include live venture development, incubator participation, or externally engaged enterprise projects (Pittaway & Edwards, 2012).

Given evidence that AI-supported decision processes can generate automation bias (Raisch & Krakowski, 2021; Shrestha et al., 2019), curriculum design incorporates structured reflection around AI use in live contexts. Assessment prioritises developmental and reflective evaluation rather than narrow performance metrics (Nabi et al., 2017). Assessment must account for the quality of learners' judgement in navigating tensions between AI-generated recommendations and contextual insights, rather than privileging optimisation based solely on AI outputs. This is operationalised through structured reflection in which learners document how AI shaped reasoning, identify governance challenges, and justify responsible judgement. Consistent with constructive alignment (Biggs, 2012), evaluation foregrounds reflexive oversight and accountable agency alongside entrepreneurial outcomes. Through this positioning, AI integration supports the development of entrepreneurial capability, identity formation, and responsible agency within lived practice. This progression is illustrated in Fig. 2, where learners navigate AI-informed decisions within a socio-technical context, exercising responsibility and accountability for outcomes.

Across the three stages, AI shifts from the object of conceptual inquiry to a tool within structured entrepreneurial rehearsal and ultimately to an embedded element of venture-level practice. Each stage represents a structured deepening of AI-enabled entrepreneurial capability, with later stages presupposing and extending foundations established in earlier orientations: from conceptual literacy and analytical understanding to applied integration and evaluative judgement, and ultimately to capability, identity formation, and responsible agency within AI-embedded entrepreneurial ecosystems. The following section formalises this progression as an integrated framework for curriculum design and theoretical development in AI-enabled EE.

The AI-enabled entrepreneurial learning progression framework

The preceding analysis demonstrates that AI integration in EE is not a discrete curricular addition but a staged developmental progression. Conceptual literacy and analytical understanding establish the epistemic foundation upon which applied integration and evaluative judgement depend. Applied integration, in turn, enables immersive engagement in which entrepreneurial capability, identity formation, and responsible agency are exercised within AI-embedded venture contexts.

The AI-Enabled Entrepreneurial Learning Progression Framework, presented in Fig. 1, formalises this progression as a coherent pedagogical architecture. The framework specifies how purpose of learning, learning development, pedagogical orientation, AI positioning, curriculum focus, teaching activities, and assessment are

		About AI in Entrepreneurship	For AI in Entrepreneurship	Through AI in Entrepreneurship
Purpose of Learning		To develop conceptual understanding and critical judgement of AI's role within entrepreneurial processes and contexts, enabling informed, evidence-based evaluation of opportunities, risks, and strategic decisions.	To develop the competencies, confidence, and applied judgement required to integrate AI into entrepreneurial activity, enabling learners to identify opportunities, make informed decisions, and act effectively under uncertainty.	To develop AI-enabled entrepreneurial capability and mindset through experiential action and structured reflection, enabling learners to build judgement and capability in navigating uncertainty.
Learning Development		Conceptual literacy and analytical understanding of AI in entrepreneurial contexts.	Applied integration and evaluative judgement in AI-supported entrepreneurial contexts.	AI-enabled entrepreneurial capability, identity, and responsible agency.
Pedagogical Orientation		Grounded in behaviourist and cognitivist traditions, emphasising structured knowledge acquisition, conceptual clarity, and analytical evaluation of AI's role in entrepreneurship	Grounded in cognitivist and constructivist traditions, emphasising scaffolded skill development, applied judgement, and guided practice in integrating AI into entrepreneurial tasks.	Grounded in constructivist and humanist traditions, emphasising experiential learning, reflexive practice, autonomy, and the development of AI-enabled entrepreneurial identity, capability, and responsible agency.
Integrating AI within the Entrepreneurship Curriculum	*AI Positioning*	AI as object of study	AI as a tool	AI as embedded actor within entrepreneurial practice
	Curriculum Focus	Understanding AI applications, capabilities, and limitations in entrepreneurship.	Applying AI to entrepreneurial tasks and evaluating output quality.	Using AI within real venture creation and reflecting on strategic implications.
	Teaching Activities	• Case studies on AI-enabled ventures • AI-assisted Q&A on entrepreneurship concepts • Using AI to generate examples of theories • Analysis of AI-driven business models	• AI-supported business plan drafting • Analysing strengths and weaknesses of AI outputs • Hackathons using AI tools • MVP development with AI support	• AI-supported market testing • AI-driven content and prototyping • Customer engagement using AI tools • Iterative venture development with AI
	Assessment Focus	• Analytical case reports • Critical essays on AI's opportunities and risks • Presentations combining AI insights with reflection	• Reflective analysis of AI-supported tasks • Evaluation of AI-generated outputs • Applied project submissions	• Reflective journals on AI effectiveness and limitations • Evidence of venture outcomes supported by AI • Customer feedback analysis • Strategic reflection on AI dependence, human agency, governance, and ethical responsibility

Fig. 1 The AI-Enabled Entrepreneurial Learning Progression Framework

systematically aligned across three stages: About AI in Entrepreneurship, For AI in Entrepreneurship, and Through AI in Entrepreneurship.

By integrating these dimensions within a staged developmental model, the framework advances a theory-building account of how AI reshapes the progression of entrepreneurial learning. It clarifies how AI capability can be progressively developed from conceptual understanding to applied integration and evaluative judgement, to identity formation and responsible agency within AI-enabled entrepreneurial ecosystems.

Figure 1 visually synthesises the AI-Enabled Entrepreneurial Learning Progression Framework, illustrating how AI capability development unfolds cumulatively across three re-specified stages: About AI in Entrepreneurship, For AI in Entrepreneurship, and Through AI in Entrepreneurship. Rather than reproducing the traditional about–for–through distinction as static pedagogical alternatives, the framework reconceptualises these stages through the lens of AI integration, depicting a structured developmental progression.

Conceptual literacy and analytical understanding establish the epistemic foundation for applied integration and evaluative judgement. Applied integration, in turn, enables immersive engagement in which entrepreneurial capability, identity, and responsible agency are exercised within AI-embedded venture contexts.

Across this progression, AI's positioning shifts systematically from an object of conceptual inquiry (About AI in Entrepreneurship), to a strategic tool within structured entrepreneurial workflows (For AI in Entrepreneurship), to an embedded component of venture-level practice within a socio-technical decision environment (Through AI in Entrepreneurship). This staged repositioning reflects increasing depth of engagement, escalating consequence, and expanding demands on learner judgement, discretion, and accountability across the three orientations.

By aligning purpose of learning, learning development, pedagogical orientation, AI positioning, curriculum focus, teaching activities, and assessment within a coherent architecture, the framework advances a theory-building account of how AI reshapes the developmental logic of EE. It articulates a cumulative model in which AI capability deepens from conceptual understanding to applied integration and evaluative judgement, and ultimately to identity formation and responsible agency within AI-enabled entrepreneurial ecosystems.

To further clarify how the framework operates in practice, an illustrative application is presented in Fig. 2. This illustrative vignette demonstrates how AI-enabled entrepreneurial capability may develop across the three stages, highlighting how AI's role shifts from object of analysis to strategic tool, to embedded actor within a socio-technical decision environment. It also illustrates how pedagogical activities and assessment expectations evolve alongside this progression.

Conclusion

AI is increasingly embedded within entrepreneurial practice, reshaping how opportunities are identified, ventures are developed, and strategic decisions are made. Evidence indicates that AI can enhance analytical capability and decision speed (Short

About AI in Entrepreneurship
Students examine an AI-generated market opportunity report for a given venture, analysing how the system identifies target segments, predicts demand, and frames potential value propositions. Rather than acting on the output, they interrogate the underlying assumptions, data dependencies, and potential biases shaping the analysis. Through guided discussion, they compare AI-generated insights with established market research frameworks, evaluating where outputs are plausible, incomplete, or misleading. Here, AI is treated as an object of analysis, supporting the development of conceptual understanding and critical judgement regarding how AI shapes entrepreneurial reasoning. Assessment focuses on students' ability to critically evaluate AI-generated outputs and explain their implications for entrepreneurial analysis.
For AI in Entrepreneurship
Students use AI tools to support the development of a business model for a given venture, generating alternative value propositions, customer segments, and revenue models. They compare multiple AI-generated outputs, selecting, modifying, or rejecting elements based on contextual fit and strategic coherence. Structured reflection requires students to justify how AI informed their decisions and where human judgement overrode automated suggestions. Here, AI is positioned as a strategic tool within entrepreneurial tasks, and learning centres on applied integration and evaluative judgement rather than acceptance of AI outputs. Assessment emphasises the quality of students' decision-making, including their justification of how AI-generated outputs were evaluated, interpreted, adapted, or rejected in context, and their readiness to apply these judgements within structured entrepreneurial tasks.
Through AI in Entrepreneurship
Students engage in a live or simulated venture context in which AI is used to inform decisions such as customer targeting, pricing, or strategic direction. During this process, AI-generated recommendations may conflict with emerging contextual insights, such as customer feedback or resource constraints. Students must decide whether to follow, adapt, or reject AI-driven suggestions, taking responsibility for the consequences of their choices. They are required to justify their role as decision-makers within an AI-enabled environment, reflecting on how AI shaped their reasoning, actions, and outcomes. Here, AI functions as an embedded actor within a socio-technical decision environment, and learning involves the development of responsible agency, reflexive judgement, and entrepreneurial identity. Assessment focuses on both venture-related outcomes and students' reflective evaluation of their decision-making, including how AI shaped their reasoning and outcomes, how they balanced AI recommendations with contextual judgement, and how they articulate their accountability for AI-influenced decisions, including consideration of governance, ethical implications, and reliance on AI.

Fig. 2 Illustrative Application of the AI-Enabled Entrepreneurial Learning Progression Framework

& Short, 2023) while transforming innovation processes through applications in idea generation, prototyping, and product design (Roberts & Candi, 2024). AI expands the entrepreneurial opportunity landscape and alters the competitive conditions under which entrepreneurial action unfolds.

As AI increasingly shapes opportunity recognition, innovation, and venture management, the capacity to understand, integrate, and critically evaluate AI becomes a core dimension of entrepreneurial competence (Bell & Bell, 2023). Recent scholarship therefore calls for systematic, theory-informed pedagogical responses to AI in EE rather than ad hoc classroom experimentation (Winkler et al., 2023; Chen et al., 2024). However, recent reviews indicate that although interest in AI integration within EE is increasing, existing approaches remain limited and underdeveloped (Chen et al., 2024; Elsa et al., 2026; Yu et al., 2025).

This paper addresses that gap by developing the AI-Enabled Entrepreneurial Learning Progression Framework. Integrating AI into the developmental logic of the established about–for–through tradition, the framework reconceptualises AI integration not as a discrete curricular addition, but as a staged capability-development progression. It clarifies how AI capability can be systematically cultivated from conceptual literacy and analytical understanding (About AI in Entrepreneurship), to applied integration and evaluative judgement (For AI in Entrepreneurship), and ultimately to entrepreneurial capability, identity formation, and responsible agency within AI-enabled entrepreneurial ecosystems (Through AI in Entrepreneurship).

Implications for theory and practice

This paper advances EE theory by extending the established about–for–through tradition (Pittaway & Cope, 2007) to account explicitly for AI as a disrupting and structuring force within entrepreneurial practice. Rather than proposing a new typology, the AI-Enabled Entrepreneurial Learning Progression Framework reconceptualises how AI reshapes the developmental logic of this tradition. It clarifies that AI integration is not a discrete curricular addition, but a staged capability-development process in which conceptual literacy and analytical understanding (About AI in Entrepreneurship) establish the epistemic foundation for applied integration and evaluative judgement (For AI in Entrepreneurship), which in turn enables the formation of entrepreneurial capability, identity, and responsible agency within AI-embedded venture contexts (Through AI in Entrepreneurship). The framework responds to calls for more systematic and theory-informed approaches to AI integration in EE (Winkler et al., 2023; Chen et al., 2024).

The framework further demonstrates that AI integration is developmental rather than purely technical. Across the three stages, AI shifts from object of conceptual inquiry to a strategic tool within entrepreneurial workflows, to an embedded component of venture-level practice within a socio-technical decision environment. This progression underscores that AI integration is not pedagogically neutral. As AI's positioning deepens across stages, it increasingly reshapes how knowledge is constructed, how judgement is exercised, and how responsibility is enacted. This developmental positioning highlights that AI should be taught as a strategically integrated and critically examined element of entrepreneurial practice, rather than as a shortcut to task completion. By conceptualising AI capability as progressively deepening engagement rather than tool proficiency, the framework contributes to emerging scholarship positioning AI as transformative for entrepreneurial competence formation rather than merely instrumental. This emphasis on responsible agency resonates with emerging calls for AI literacy, ethics, and governance frameworks within EE (Elsa et al., 2026).

The framework also integrates learning theory with technological integration in a coherent manner. By aligning purpose of learning, learning development, pedagogical orientation, AI positioning, curriculum focus, teaching activities, and assessment across stages, it offers a theoretically grounded architecture for curriculum sequencing. This moves beyond fragmented classroom experimentation and provides a structured basis for programme design, assessment alignment, and future empirical

investigation into AI-enabled entrepreneurial capability formation. By situating AI within a theoretically grounded educational tradition, the framework strengthens the legitimacy of AI integration in EE (Bell and Bell, 2025). It offers a defensible basis for staged incorporation, supporting curricular coherence and academic rigour in the face of rapid technological change.

In practical terms, the framework provides educators with a developmental blueprint for embedding AI within entrepreneurship curricula without collapsing conceptual, applied, and experiential learning into a single undifferentiated approach. It supports clearer alignment between learning outcomes and AI positioning, encourages intentional progression from conceptual literacy to applied integration and ultimately to responsible agency, and offers a scaffold for evaluating AI-enabled learning design.

Collectively, these implications position the framework as both an extension of the about–for–through tradition and a theory-building response to the technological transformation of entrepreneurial practice.

The growing pervasiveness of AI in entrepreneurial ecosystems demands more than incremental pedagogical adjustment. It requires rethinking how entrepreneurial capability is progressively formed. By reconceptualising the about–for–through tradition as a staged developmental architecture through which AI-enabled judgement, discretion, and accountability are cultivated over time, the AI-Enabled Entrepreneurial Learning Progression Framework advances this shift. It reframes AI not as a tool to be appended to existing curricula, but as a structuring force that reshapes how knowledge, capability, and responsibility develop within EE. It establishes a foundation for future empirical testing and curriculum innovation grounded in developmental coherence rather than technological enthusiasm alone.

Limitations and future research

The AI-Enabled Entrepreneurial Learning Progression Framework is a conceptual contribution and therefore requires empirical examination. While the framework proposes a staged developmental progression across the three AI-enabled orientations, the causal and sequencing relationships between these stages remain theoretically articulated rather than empirically examined. The framework should therefore be understood as a theory-building platform that invites systematic investigation rather than as a prescriptive curriculum template. The framework also assumes that AI-enabled capability is developed alongside, rather than as a substitute for, foundational entrepreneurial knowledge and skills. Future research should therefore examine how AI integration complements rather than displaces core elements of EE and entrepreneurial capability formation.

Future research should examine whether the proposed progression operates developmentally in practice. Longitudinal and quasi-experimental studies could explore whether conceptual literacy provides measurable foundations for applied integration, and whether applied integration predicts subsequent development of reflexive judgement, identity formation, and responsible agency in AI-embedded venture contexts. Measurement development is particularly needed to operationalise constructs such

as AI-enabled entrepreneurial capability and responsible agency as multidimensional phenomena rather than proxies for technical proficiency.

The framework also raises important sequencing questions. Research may examine whether premature immersion in AI-supported experiential contexts risks superficial competence or automation bias, particularly if conceptual foundations are underdeveloped. Comparative studies across programmes, learner profiles, and institutional contexts would help clarify whether the staged progression is universal, or contingent upon prior knowledge, disciplinary background, or ecosystem conditions.

Finally, the model foregrounds AI as an embedded element within venture decision environments, inviting interdisciplinary inquiry into human–AI interaction, sociotechnical systems, and entrepreneurial cognition. Empirical work could explore how learners negotiate judgement, authority, and accountability when AI shapes opportunity framing and strategic direction. Such research would extend the framework beyond curriculum design toward a broader understanding of AI-enabled entrepreneurial capability formation.

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