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Cultivating Kidpreneurship in the USA: The SPARK Framework for AI-Driven Business Simulation-Based Entrepreneurial Development in K-12 Education

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Abstract

The United States is simultaneously experiencing a historic surge in entrepreneurial activity and a deepening readiness gap in its K-12 education system. U.S. Census Bureau data show that 5,479,144 new business applications were filed in 2023 - a record high - and the 2024-2025 Global Entrepreneurship Monitor U.S. report finds that 18-to-24-year-olds now exhibit the highest entrepreneurial intentions of any cohort, with 24% currently engaged in early-stage venture activity (Babson College, 2025; U.S. Census Bureau, 2025). Yet 17% of American 15-year-olds fall below baseline financial-literacy proficiency (OECD, 2024), 86% of students report using generative AI in school, while 58% of educators have received no formal AI training (Hunt Institute, 2025), and the post-ESSER fiscal cliff has constrained district capacity to invest in advanced ed-tech (Utah State Board of Education, 2025). This paper proposes the SPARK Framework - a conceptual integration of Quidwai's (2023) human-centered prompting routine (Situation, Problem, Aspiration, Results, Kismet) with AI-driven Business Simulation Games (BSGs) - as a scalable pedagogical architecture for cultivating kidpreneurship in U.S. K-12 education. Adopting Jaakkola's (2020) theory-synthesis methodology, the paper integrates Kolb's (1984) Experiential Learning Theory, Ajzen's (1991) Theory of Planned Behaviour, Nonaka and Takeuchi's (1995) SECI knowledge-creation model, the European Commission's EntreComp competence framework (Bacigalupo et al., 2016), and Long and Magerko's (2020) AI literacy competencies. The synthesis yields a five-panel conceptual architecture that operationalizes kidpreneurship development across cognitive, affective, behavioral, educational and economic outcome layers. Findings indicate that AI-augmented BSGs, when scaffolded by SPARK, are positioned to enhance entrepreneurial self-efficacy (Newman et al., 2019), opportunity recognition, financial literacy and AI literacy concurrently. The paper further offers original contributions in the form of (i) a novel mapping of SPARK phases onto SECI knowledge dimensions and EntreComp competence areas, (ii) a developmental K-12 scaffolding pathway across elementary, middle and high school, and (iii) an actionable policy roadmap addressing the digital divide, algorithmic bias, and the human-in-the-loop imperative. The paper concludes with a structured agenda for empirical validation.

Keywords: Kidpreneurship, SPARK Framework, Artificial Intelligence, Business Simulation Games, K-12 Education, Experiential Learning, Entrepreneurial Self-Efficacy, EntreComp, AI Literacy, Theory Synthesis.

1. Introduction

1.1 The Convergent Inflection Point

The United States stands at a convergent inflection point. Three structural forces - an unprecedented entrepreneurial surge, the rapid mainstreaming of generative artificial intelligence (AI) in education, and a persistent K-12 readiness gap - are simultaneously reshaping how American children acquire economic agency. U.S. Census Bureau Business Formation Statistics record 5,479,144 new business applications in 2023 (the highest year on record) and over 5.1 million in 2024 (U.S. Census Bureau, 2025; Commerce Institute, 2026). The 2024-2025 Global Entrepreneurship Monitor (GEM) United States report finds that Total Entrepreneurial Activity (TEA) has rebounded to 19% of the adult population, with the youngest demographic cohort (18-24) now leading: 24% are active early-stage entrepreneurs and 21% intend to launch within three years (Babson College, 2025; Global Entrepreneurship Monitor, 2025).

This generational shift is, however, not yet matched by the formal education system. The OECD's PISA 2022 financial-literacy assessment - in which 4,552 U.S. 15-year-olds participated - found that 17% of American students fall below baseline proficiency, meaning they cannot apply financial knowledge to real-life decisions (OECD, 2024). Although the U.S. mean of 505 points sits above the OECD average of 498, socio-economically advantaged students outperformed disadvantaged peers by 87 points across the OECD - a gap that mirrors broader inequities in American entrepreneurship education access (OECD, 2024). At the same time, the Hunt Institute (2025) reports that 86% of U.S. students used generative AI tools during the 2024-2025 academic year, while 58% of educators received no formal AI professional development. The combination produces a paradox: the technology most capable of personalizing entrepreneurial learning is being deployed at scale without the pedagogical scaffolding that would make it educationally productive.

1.2 The Kidpreneurship Phenomenon

Kidpreneurship - children and adolescents engaging in age-appropriate entrepreneurial activity - has emerged organically alongside this turbulence. Junior Achievement USA's 2020 Youth CARAVAN survey of 1,000 U.S. teenagers (aged 13-17) found that 51% expressed a desire to start their own business and 84% believed entrepreneurial skills should be a core component of school curricula (Junior Achievement USA, 2020). NFTE-commissioned research demonstrates that participation in youth entrepreneurship programmes increases interest in attending college by 32% (Network for Teaching Entrepreneurship, 2024). Yet kidpreneurship in the digital age also exposes children to non-trivial ethical risks: digital monetization through e-commerce, social-media sponsorships and play-to-earn ecosystems creates earning pathways that are also vectors for fraud, algorithmic manipulation and the gamification of speculative financial behavior (Money and Pensions Service, 2024).

1.3 Research Problem and Questions

Existing pedagogical responses to this convergence are fragmented. Established programmes such as the Network for Teaching Entrepreneurship (NFTE) and Junior Achievement USA have produced rigorous longitudinal evidence on entrepreneurship education outcomes (Network for Teaching Entrepreneurship, 2024; Junior Achievement USA, 2024); recent efforts such as NFTE's 'Make AI Your Cofounder' integrate generative AI directly into youth entrepreneurship curricula (Network for Teaching Entrepreneurship, 2024). The empirical literature on Business Simulation Games (BSGs) likewise demonstrates significant effects on entrepreneurial intention and self-efficacy in higher education (Liu et al., 2022; Fox, Pittaway and Uzuegbunam, 2018), and a recent systematic review of 46 empirical BSG-with-emerging-technology studies confirms quasi-experimental and experimental evidence of positive learning outcomes (Sheikh et al., 2025). However, a structured conceptual model that (i) explicitly integrates AI literacy with entrepreneurship education at K-12 level, (ii) is grounded in validated entrepreneurship competence frameworks such as EntreComp, and (iii) addresses the human-in-the-loop imperative is missing from the literature.

This paper addresses that gap by asking three research questions:

- RQ1: How can a structured, human-centered AI prompting routine be conceptually integrated with AI-driven Business Simulation Games to cultivate kidpreneurship competencies in U.S. K-12 education?
- RQ2: Which cognitive, affective, behavioral, educational and economic outcomes can such an integrated model be expected to yield, and through what mediating mechanisms?
- RQ3: What systemic enablers and constraints determine the model's scalability across diverse U.S. K-12 contexts?

1.4 Contribution

This paper contributes to the literature in three distinct ways. First, it introduces the SPARK-K12 Framework, an original synthesis of Quidwai's (2023) human-AI prompting routine, validated entrepreneurship competence frameworks (Bacigalupo et al., 2016), and the AI literacy competencies of Long and Magerko (2020). Second, it advances theory by mapping SPARK phases onto Nonaka and Takeuchi's (1995) SECI knowledge-creation model, demonstrating that AI functions primarily within the Combination phase while the Kismet parameter operates as an Externalization catalyst. Third, the paper offers an actionable developmental scaffolding pathway across the K-12 age range and a policy roadmap for systemic implementation. By extending the author's prior work on AI-driven business simulations for adult entrepreneurship (Author, 2024) into the K-12 domain, the paper completes a coherent research arc on simulation-based entrepreneurial development across the life course.

The remainder of the paper proceeds as follows. Section 2 reviews five interconnected literatures. Section 3 details the theory-synthesis methodology. Section 4 presents the integrated SPARK-K12 Framework. Section 5 articulates conceptual findings. Section 6 discusses implementation challenges and policy implications. Section 7 concludes and outlines an empirical validation agenda.

2. Literature Review

The proposed framework integrates five interconnected bodies of literature: (i) youth entrepreneurship and the U.S. readiness gap; (ii) experiential learning theory and Business Simulation Games; (iii) the SECI knowledge-creation model; (iv) entrepreneurship competence frameworks, particularly EntreComp; and (v) AI literacy and human-centered prompting. Each is reviewed below to surface the conceptual building blocks for the synthesis presented in Section 4.

2.1 Youth Entrepreneurship and the U.S. K-12 Readiness Gap

The empirical case for youth entrepreneurship education in the United States rests on a substantial evidence base. NFTE alumni studies have demonstrated, since their inception in the early 1990s, that participation in entrepreneurship education programmes increases entrepreneurial self-efficacy, locus of control, occupational aspirations and college-going intent (Network for Teaching Entrepreneurship, 2024). A five-year evaluation conducted by Brandeis University (1993-1998) found significant impact on participants' entrepreneurship knowledge and entrepreneurial self-efficacy, while two Harvard Graduate School of Education studies (2003 and 2004) found NFTE students increased their college and career orientation and demonstrated higher measures of entrepreneurial behavior, especially in leadership (Network for Teaching Entrepreneurship, 2024). NFTE-commissioned research more broadly indicates that interest in attending college increased by 32% among youth participating in entrepreneurship programmes (Mid-Atlantic Education Alliance, 2024).

Adolescence is the critical developmental window for these effects. Newman et al. (2019), in their systematic review of entrepreneurial self-efficacy (ESE), explicitly identify the need to examine the developmental precursors of ESE in childhood, adolescence and early adulthood as a research priority. Ho et al. (2018), using a two-wave online survey of 328 Singaporean secondary-school students aged 13-16, found that adolescents who completed a structured entrepreneurship training programme displayed significantly higher entrepreneurial alertness and self-efficacy than a control group, with both passive and active learning elements contributing independently. More recent psychometric work by Liu et al. (2024), through a four-study mixed-methods design including a Delphi panel and structural equation modelling validation, developed and validated the Adolescent Entrepreneurial Attributes (AEA) scale, which captures innovativeness, opportunity recognition, risk-taking propensity, proactiveness, vision-driven thinking, ethical thinking, and communication and collaboration in adolescent learners. The existence of validated K-12-appropriate measurement instruments such as the AEA, the Battery for the Assessment of the Enterprising Personality-Adaptive (BEPE-A; Postigo et al., 2021), and NFTE's Entrepreneurial Mindset Index (EMI) is critical for any future empirical validation of the framework proposed here.

The U.S. K-12 readiness gap, however, is widening. The OECD (2024) PISA 2022 financial-literacy results show that 17% of American 15-year-olds fall below baseline proficiency and that the gap between socio-economically advantaged and disadvantaged students in financial literacy averages 87 points across the OECD - a structural inequity that, in the U.S. context, maps directly onto disparities in access to entrepreneurship education (Aspen Institute, 2008). The Aspen Youth Entrepreneurship Strategy Group has long argued that children in low-income communities frequently develop 'business smarts' through environmental adversity but lack the formal toolkit to channel these traits into structured ventures (Aspen Institute, 2008).

2.2 Experiential Learning Theory and Business Simulation Games

Kolb's (1984) Experiential Learning Theory (ELT) remains the canonical framework for active, learner-centered entrepreneurship education. ELT proposes a four-stage cycle: concrete experience, reflective observation, abstract conceptualization and active experimentation. Motta and Galina (2023), in a systematic literature review of experiential learning in entrepreneurship education, conclude that experiential approaches have a positive and statistically significant effect on entrepreneurial intention and competence development. Business Simulation Games (BSGs) are widely regarded as the highest-fidelity experiential learning tool available to educators (Fox, Pittaway and Uzuegbunam, 2018). Within a BSG, learners manage virtual companies, allocate finite resources, analyze market data, forecast demand and compete with peer-led teams or computer agents, traversing all four stages of the Kolb cycle within a single learning session.

Empirical evidence on BSG efficacy is robust. Liu et al. (2022), in a quasi-experimental study published in Frontiers in Psychology, demonstrated that AI-augmented business simulations significantly improved entrepreneurial attitudes among undergraduates, with adaptive feedback and realistic competitor modelling identified as the strongest determinants of intention to start a business. A 2025 systematic review by Sheikh et al. of 46 empirical studies on BSGs integrated with emerging technologies (AI, generative AI chatbots, virtual reality, and blockchain) found that 14 used quasi-experimental designs and 6 used experimental designs, and that the evidence collectively supports positive effects on cognitive, behavioral and affective learning outcomes. Lin and Wang (2025), studying virtual-reality BSGs in management education, further demonstrated that instructional and technological support reduce extraneous cognitive load while enhancing learning achievement.

K-12-specific evidence is more limited but encouraging. Conner, Roberts and Stripling (2022), in a quasi-experimental study published in the Journal of Agricultural Education, examined eighth-grade students participating in a business-management simulation embedded in an exploratory agriculture course. Treatment-group students achieved significantly higher business-management knowledge and entrepreneurial intent than traditionally instructed peers. Junior Achievement USA's flagship JA Titan programme, a simulation in which high-school students compete as virtual CEOs across multiple business decisions, has been deployed across thousands of U.S. schools, and JA's broader programme suite spans grades 3-12 with simulation-based, financial-literacy, and entrepreneurship modules (Junior Achievement USA, 2024). Newman et al.'s (2019) systematic ESE review explicitly recommends that future research extend simulation-based interventions earlier in the developmental trajectory.

2.3 The SECI Knowledge-Creation Model

Nonaka and Takeuchi's (1995) SECI model maps the dynamics of knowledge creation through four interrelated phases: Socialization (tacit-to-tacit, through shared experience), Externalization (tacit-to-explicit, through articulation), Combination (explicit-to-explicit, through synthesis), and Internalization (explicit-to-tacit, through embodied practice). The 'Ba' concept (Nonaka and Konno, 1998) extends the model by emphasizing the contextual, often physical or virtual space in which knowledge conversion occurs. The SECI model is particularly germane to AI-augmented learning because it provides a vocabulary for distinguishing what AI can do well from what only humans can do.

In the entrepreneurial education context, AI excels at the Combination phase: synthesizing market data, reformulating complex information, generating SWOT analyses and producing executive summaries. However, AI struggles to substitute for the Socialization phase, which depends on shared embodied experience, peer dialogue and the silent transfer of tacit norms. Externalization - articulating tacit insight - is the phase in which the SPARK Framework's Kismet parameter operates as a deliberate catalyst (see Section 4). Internalization, the phase in which simulated experience is converted into durable practical wisdom, is mediated primarily by reflective debriefing with human mentors. This SECI mapping provides the theoretical foundation for the human-in-the-loop imperative articulated in Section 6.

2.4 The EntreComp Entrepreneurship Competence Framework

The European Commission's Joint Research Centre developed the EntreComp framework (Bacigalupo et al., 2016) as the de facto reference for entrepreneurship competence in education and training. EntreComp comprises three competence areas - Ideas and Opportunities, Resources, and Into Action - each containing five competences for a total of fifteen, mapped onto an eight-level progression model and 442 learning outcomes. The framework defines entrepreneurship as 'when you act upon opportunities and ideas and transform them into (financial, cultural, social) value for others' (Bacigalupo et al., 2016, p. 6), explicitly broadening the construct beyond commercial venture creation.

EntreComp has become widely adopted in policy and curriculum design across Europe and increasingly internationally. A 2024 systematic literature review by Sirelkhatim and Gangi identified 140 documents that have utilised the framework for self-assessment tool development, programme evaluation, and EU policy analysis. EntreComp's eight-level progression model is particularly valuable for K-12 design because it provides explicit, age-appropriate developmental milestones that map onto the elementary, middle and high-school stages. The framework is therefore adopted in this paper as the structural backbone for the developmental scaffolding pathway presented in Section 4.

2.5 AI Literacy and Human-Centred Prompting

As AI becomes ubiquitous in education, AI literacy has emerged as a parallel competence requirement. Long and Magerko (2020), in their seminal CHI paper, defined AI literacy as 'a set of competencies that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace' (p. 2). They synthesised this construct into seventeen competencies organised around five themes: What is AI? What can AI do? How does AI work? How should AI be used? And how do people perceive AI? Subsequent reviews (Ng et al., 2021; Almatrafi et al., 2024) have refined these into four to six core constructs encompassing recognition, understanding, application, evaluation, ethical navigation and (debatably) creation.

However, simply knowing about AI is insufficient for productive collaboration with it. Quidwai (2023), drawing on her experience as a former Apple education executive and through the Designing Schools platform, developed the SPARK Framework as a design-thinking-derived prompting routine that positions AI as a 'thought partner' rather than an oracle. The framework comprises five sequential steps: Situation (describing the context), Problem (articulating the friction), Aspiration (defining the desired future state), Results (specifying measurable benchmarks), and Kismet (deliberately engineering serendipity by inviting surprising or lateral suggestions). The Kismet parameter is unique to SPARK and explicitly addresses the well-documented tendency of large language models to produce predictable, mode-collapsed outputs (Quidwai, 2023; Designing Schools, 2023). Crucially, SPARK is the only widely adopted education-focused prompting framework that explicitly requires the human to 'prompt the human before the machine' - that is, to clarify objectives in dialogue with another person before formulating an AI prompt (Quidwai, 2024).

By integrating SPARK's structured cognitive scaffolding with AI-driven BSGs, the present paper proposes a mechanism by which AI literacy and entrepreneurial competence can be cultivated concurrently, with each reinforcing the other.

3. Methodology

3.1 Research Design

This paper employs theory synthesis, a recognized mode of conceptual research in business and educational scholarship (Hirschheim, 2008; MacInnis, 2011; Jaakkola, 2020). Unlike empirical research, which generates new knowledge through primary data collection, conceptual research generates new knowledge through the logical integration, synthesis and re-contextualisation of existing theories (Jaakkola, 2020). Conceptual articles are particularly suited to phenomena - such as kidpreneurship in the age of generative AI - that have been addressed in fragmented fashion across multiple disciplines, including developmental psychology, business management, computer science and education policy.

3.2 The Theory Synthesis Approach

Jaakkola (2020) distinguishes four approaches to conceptual research design: theory adaptation, theory synthesis, typology, and model building. Theory synthesis is selected here because the paper's purpose is to achieve conceptual integration across multiple, currently siloed perspectives in order to offer a higher-order view of a phenomenon. Theory synthesis requires an explicit distinction between domain theory (the substantive topic under investigation) and method theory (the meta-level conceptual lens applied to organise the domain) (Jaakkola, 2020):

- Domain theory: youth entrepreneurship and K-12 entrepreneurship education (encompassing Kolb's (1984) Experiential Learning Theory, Ajzen's (1991) Theory of Planned Behaviour, and the empirical literature on Business Simulation Games).
- Method theory: the SPARK Framework (Quidwai, 2023), Nonaka and Takeuchi's (1995) SECI knowledge-creation model, the EntreComp framework (Bacigalupo et al., 2016), and Long and

Magerko's (2020) AI literacy competencies. These provide the structured scaffolding required to reorganise and elevate the domain theory in an AI-augmented context.

3.3 The Chain of Evidence

Jaakkola (2020) requires conceptual papers to make their chain of evidence visible through transparent narrative reasoning that links claims to grounds and warrants. The grounds (evidence) for this paper are: (i) the documented efficacy of BSGs in increasing entrepreneurial self-efficacy and intention, supported by quasi-experimental and experimental evidence in K-12 and higher-education settings (Liu et al., 2022; Conner, Roberts and Stripling, 2022; Fox, Pittaway and Uzuegbunam, 2018; Sheikh et al., 2025); (ii) the proven capacity of generative AI to process explicit data, provide adaptive real-time feedback, and simulate complex personas in educational settings (Eltahir and Babiker, 2024; Liu et al., 2022; UNESCO, 2024); and (iii) the validated structure of competence frameworks for entrepreneurship (EntreComp; Bacigalupo et al., 2016) and AI literacy (Long and Magerko, 2020). The warrant - the connecting assumption - is that unstructured AI usage in K-12 settings degrades critical thinking and student agency (EdTech Digest, 2026; Hunt Institute, 2025), and that a structured human-centred prompting routine can mitigate this risk while preserving AI's affordances for personalised learning.

The central claim is therefore that intentionally imposing the structured cognitive routine of the SPARK Framework onto AI-driven business simulations, scaffolded developmentally across K-12, will optimise student engagement, safeguard intellectual agency and cultivate a resilient entrepreneurial mindset in U.S. youth - while simultaneously building AI literacy as a complementary competence.

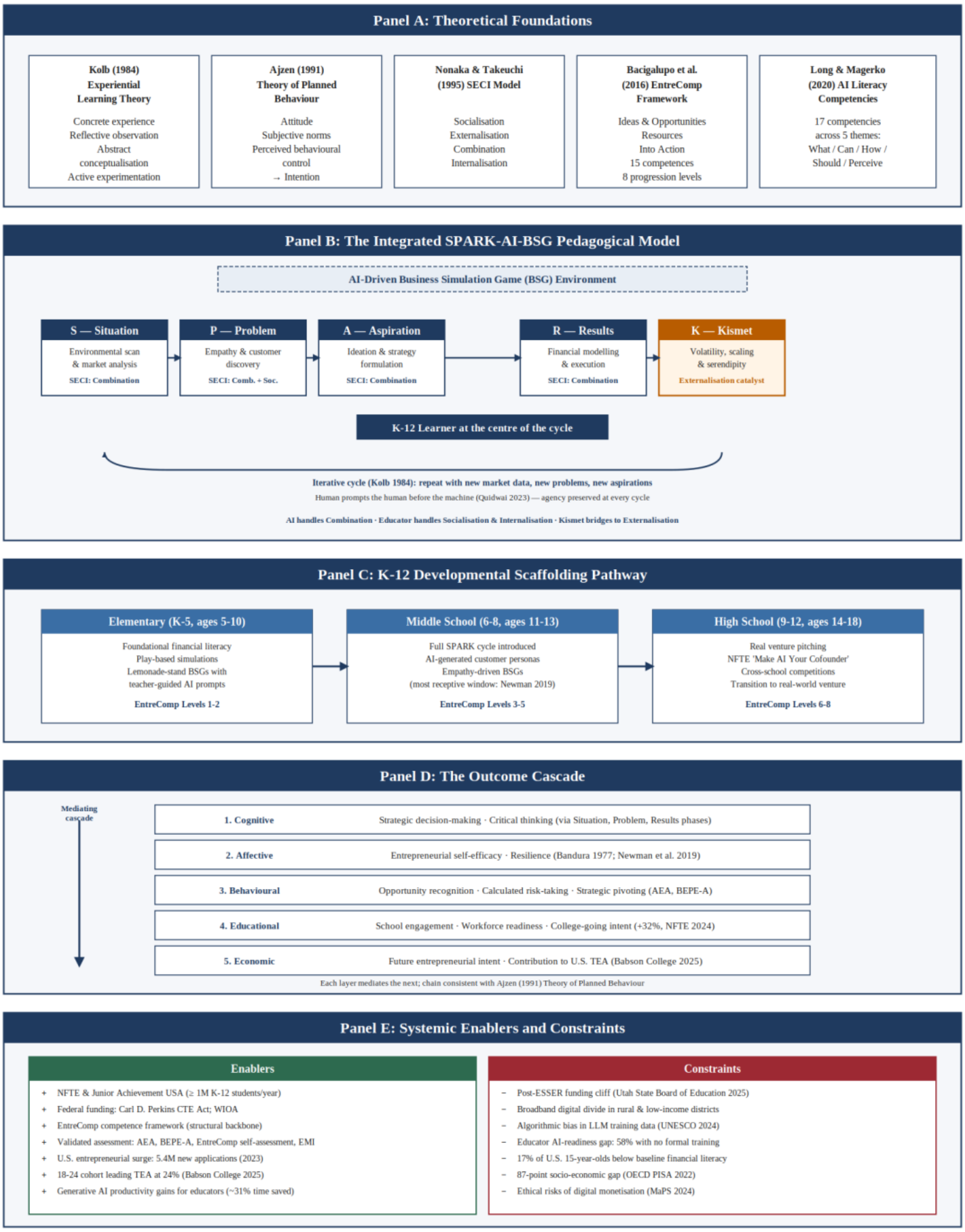
3.4 Source Selection and Quality Criteria

Sources for this synthesis were drawn primarily from peer-reviewed journals indexed in Scopus and Web of Science (e.g., Frontiers in Psychology, Journal of Business Venturing, International Journal of Management Education, Computers and Education, Teaching and Teacher Education, Journal of Agricultural Education, ACM CHI Proceedings, Sustainability), authoritative grey literature from policy-setting organisations (OECD, UNESCO, European Commission JRC, U.S. Census Bureau, NORC at the University of Chicago, Brookings Institution), and reports from established practitioner networks with rigorous evaluation evidence (NFTE, Junior Achievement USA, GEM Consortium, Babson College). Priority was given to publications from 2018-2026 to ensure currency, with seminal foundational works (Kolb, 1984; Ajzen, 1991; Nonaka and Takeuchi, 1995; Bandura, 1977) included for theoretical anchoring. All web-accessed sources were verified during April 2026.

4. The SPARK-K12 Framework

The synthesis of the literature reviewed in Section 2 yields the integrated SPARK-K12 Framework, presented in Figure 1 as a five-panel architecture. Panel A presents the theoretical foundations; Panel B presents the integrated SPARK-AI-BSG pedagogical model; Panel C presents the K-12 developmental scaffolding pathway; Panel D presents the outcome cascade; and Panel E presents the systemic enablers and constraints. Each panel is unpacked in the subsections below.

Figure 1: The SPARK-K12 Framework



The SPARK-K12 Framework: an integrated conceptual architecture for AI-driven kidpreneurship development. Panel A: theoretical foundations. Panel B: the integrated SPARK-AI-BSG pedagogical model with iterative cyclical flow. Panel C: K-12 developmental scaffolding pathway. Panel D: outcome cascade. Panel E: systemic enablers and constraints. Source: synthesised by the author from Kolb (1984), Ajzen (1991), Nonaka and Takeuchi (1995), Bacigalupo et al. (2016), Long and Magerko (2020), Quidwai (2023), and Jaakkola (2020).

4.1 Panel A: Theoretical Foundations

The framework is anchored in five complementary theoretical traditions. Kolb's (1984) Experiential Learning Theory provides the pedagogical grammar of cyclical, learner-driven experience. Ajzen's (1991) Theory of Planned Behaviour identifies attitude, subjective norms and perceived behavioural control as the proximal determinants of intention - and therefore the targets of any educational intervention seeking to elevate entrepreneurial intention. Nonaka and Takeuchi's (1995) SECI model provides the vocabulary for distinguishing what AI can do well (Combination) from what it cannot (Socialisation, Internalisation). Bacigalupo et al.'s (2016) EntreComp framework provides the validated, eight-level competence structure that scaffolds developmental progression across K-12. Long and Magerko's (2020) seventeen AI literacy competencies provide the construct map for the AI-related learning outcomes that the framework cultivates as a parallel competence.

4.2 Panel B: The Integrated SPARK-AI-BSG Model

The core of the framework is the integration of the five SPARK phases (Situation, Problem, Aspiration, Results, Kismet) into the iterative cycle of an AI-driven Business Simulation Game. The K-12 learner sits at the centre, with the AI-driven BSG environment forming the outer learning context. The five SPARK phases map onto the entrepreneurial lifecycle and the SECI knowledge phases as detailed in Table 1.

Table 1: Mapping SPARK Phases to Entrepreneurial Lifecycle, SECI Phase, EntreComp Area, and AI Literacy Competency

SPARK Phase	Lifecycle Stage	SECI Phase	EntreComp Area	AI Literacy Competency (Long & Magerko)
S - Situation	Environmental scan & market analysis	Combination	Ideas and Opportunities (Spotting opportunities)	Data Literacy; Critically Interpreting Data
P - Problem	Empathy & customer discovery	Combination + simulated Socialisation	Ideas and Opportunities (Valuing ideas)	AI's Strengths & Weaknesses; Communication
A - Aspiration	Ideation & strategy formulation	Combination	Resources (Vision; Self-awareness)	What AI Can Do; Imagine Future AI
R - Results	Financial modelling & execution	Combination	Resources + Into Action (Mobilising resources; Planning)	Decision-making; Action & Reaction
K - Kismet	Volatility, scaling & serendipity	Externalisation catalyst	Into Action (Coping with ambiguity, uncertainty and risk)	Ethics; How AI Should be Used

4.2.1 Phase 1 - Situation

In the Situation phase, the learner is required to perform a structured environmental scan of the simulated market before undertaking any decision. The student prompts the AI - for example, 'Acting as a senior market-research analyst, summarise the current consumer sentiment toward sustainable packaging in this simulated eco-apparel market, and identify three demand-side risks.' The AI synthesises explicit data from the simulation engine into a coherent executive summary, operating squarely within Nonaka and Takeuchi's (1995) Combination phase. The student must critically interpret the output - exercising Long and Magerko's (2020) Data Literacy and Critically Interpreting Data competencies. This phase aligns with the EntreComp 'Spotting opportunities' competence (Bacigalupo et al., 2016).

4.2.2 Phase 2 - Problem

Customer discovery is widely identified as the most under-developed entrepreneurial skill in adolescent learners (Network for Teaching Entrepreneurship, 2024). The Problem phase requires the learner to articulate the core friction or unmet need and to validate this through simulated customer interviews. AI-generated dynamic customer personas - drawing on the capacity of generative AI to simulate diverse persona archetypes - allow students to conduct empathy interviews without the social anxiety that frequently inhibits real-world customer outreach (UNESCO, 2024). Through this AI-mediated Socialisation analogue, students develop interrogative communication, active listening and the EntreComp 'Valuing ideas' competence.

4.2.3 Phase 3 - Aspiration

The Aspiration phase positions AI as an ideation sparring partner. Students articulate their desired future state and use the AI to surface adjacent strategies, run rapid SWOT analyses and stress-test assumptions. Crucially, students are explicitly required to critically evaluate AI suggestions for bias, feasibility and alignment with the EntreComp 'Vision' competence. This phase exercises Long and Magerko's (2020) 'Imagine Future AI' competency by asking students to anticipate how AI itself might evolve to disrupt their proposed strategy.

4.2.4 Phase 4 - Results

In the Results phase, AI provides real-time predictive analytics on the consequences of student decisions. Students learn to interpret financial metrics, model cash-flow scenarios and adjust pricing strategies in response to AI-generated demand forecasts. This phase directly cultivates the financial self-efficacy that Newman et al.'s (2019) systematic review identifies as a strong predictor of subsequent entrepreneurial behavior, while simultaneously developing the EntreComp 'Mobilising resources' and 'Planning and management' competences.

4.2.5 Phase 5 - Kismet

The most innovative aspect of the model is the deliberate integration of Kismet. Modern markets exhibit conditions described as VUCA (volatile, uncertain, complex and ambiguous) or BANI (brittle, anxious, non-linear, incomprehensible). A fully predictable simulation fails to prepare students for this reality. The instructor - or the AI engine itself - injects randomized black-swan events: a geopolitical tariff shock, a viral social-media trend, a localized supply disruption. Students must abandon rigid plans and rapidly formulate crisis-management protocols. The Kismet parameter functions as an Externalisation catalyst in Nonaka and Takeuchi's (1995) terms: it forces students to articulate previously tacit assumptions and convert them into explicit, defensible decisions. The cultivated outcome is the EntreComp 'Coping with ambiguity, uncertainty and risk' competence (Bacigalupo et al., 2016).

4.3 Panel C: The K-12 Developmental Scaffolding Pathway

Effective implementation requires age-appropriate scaffolding aligned with cognitive and developmental milestones. Panel C of Figure 1 articulates a three-stage pathway. The Elementary stage (K-5, ages 5-10) introduces foundational financial literacy through play-based simulations - lemonade-stand BSGs with teacher-guided AI prompts - cultivating basic awareness of value exchange. This aligns with EntreComp progression levels 1-2 (Bacigalupo et al., 2016). The Middle School stage (grades 6-8, ages 11-13) introduces the full SPARK cycle, with AI-generated customer personas and empathy-driven BSGs. This is the developmental window that Newman et al. (2019) and the Network for Teaching Entrepreneurship (2024) identify as most receptive to entrepreneurial mindset cultivation, aligning with EntreComp progression levels 3-5. The High School stage (grades 9-12, ages 14-18) introduces real venture pitching, programmes such as NFTE's 'Make AI Your Cofounder' (Network for Teaching Entrepreneurship, 2024), and cross-school competitions. This stage maps onto EntreComp progression levels 6-8 and operationalises the transition from simulation to real-world venture creation.

4.4 Panel D: The Outcome Cascade

Panel D of Figure 1 articulates the framework's outcome cascade, organised across five mediating layers consistent with Bandura's (1977) social cognitive theory and Ajzen's (1991) Theory of Planned Behaviour:

- Cognitive outcomes: strategic decision-making and critical thinking, cultivated primarily through the Situation, Problem and Results phases.
- Affective outcomes: entrepreneurial self-efficacy and resilience, cultivated through cumulative cycles of simulated success and failure (Bandura, 1977; Newman et al., 2019).
- Behavioural outcomes: opportunity recognition, calculated risk-taking and strategic pivoting, observable within the simulation logs and assessable using validated instruments such as the AEA (Liu et al., 2024) and BEPE-A (Postigo et al., 2021).
- Educational outcomes: school engagement and workforce readiness, with entrepreneurship education well-documented to increase college-going intent (Network for Teaching Entrepreneurship, 2024).

- Economic outcomes: future entrepreneurial intent and contribution to U.S. Total Entrepreneurial Activity (TEA), measurable longitudinally against GEM benchmarks (Babson College, 2025).

Each outcome layer mediates the next: cognitive gains drive affective changes, which drive behavioural changes, which drive educational outcomes, which feed long-run economic outcomes. This causal chain is consistent with the established psychometric literature on entrepreneurial intention (Ajzen, 1991; Newman et al., 2019).

4.5 Panel E: Systemic Enablers and Constraints

Panel E of Figure 1 identifies the systemic enablers and constraints that determine the framework's scalability. Enablers include the established networks of NFTE and Junior Achievement USA, which collectively reach more than a million U.S. K-12 students annually (Network for Teaching Entrepreneurship, 2024; Junior Achievement USA, 2024); existing federal funding mechanisms (Carl D. Perkins Career and Technical Education Act; Workforce Innovation and Opportunity Act); the structural backbone provided by EntreComp; and validated assessment instruments. Constraints, by contrast, include the post-ESSER funding cliff (Utah State Board of Education, 2025), the broadband digital divide, algorithmic bias in LLM training data, the educator AI-readiness gap (Hunt Institute, 2025), and the ethical risks of digital monetisation (Money and Pensions Service, 2024). Section 6 returns to these constraints in detail.

5. Findings

The synthesis presented in Section 4 yields seven conceptual findings, derived through Jaakkola's (2020) chain of evidence reasoning and grounded in the empirical literature reviewed in Section 2. These findings are conceptual rather than empirical: they generate testable propositions for subsequent empirical validation rather than reporting primary data.

5.1 Finding 1: Concurrent Cultivation of Entrepreneurial and AI Literacy Competences

The most distinctive contribution of the SPARK-K12 Framework is its capacity to cultivate entrepreneurial competence (per Bacigalupo et al., 2016) and AI literacy (per Long and Magerko, 2020) concurrently rather than sequentially. The mapping in Table 1 demonstrates that each SPARK phase activates specific EntreComp competencies and specific AI literacy competencies simultaneously. Existing K-12 entrepreneurship programmes typically address AI literacy as an add-on or omit it entirely; the SPARK-K12 Framework structurally embeds AI literacy in the entrepreneurial workflow, producing learners who are simultaneously entrepreneurial-competent and AI-literate by design.

5.2 Finding 2: SPARK as a Mechanism for Preserving Student Agency in AI-Augmented Learning

A persistent concern in the AI-and-education literature is that unstructured AI usage degrades critical thinking, reduces metacognitive engagement and produces academic-integrity risks (Hunt Institute, 2025; EdTech Digest, 2026). The SPARK Framework's pre-prompt cognitive scaffolding directly addresses this risk by requiring the human learner to articulate Situation, Problem, Aspiration and Results before invoking the AI. As Quidwai (2023) puts it, the framework requires students to 'prompt the human before the machine.' This preserves student agency and ensures that AI usage augments rather than substitutes for cognitive effort.

5.3 Finding 3: Kismet as a Theoretical Bridge between AI Combination and Human Externalisation

The Kismet parameter is theoretically novel. While SPARK as a whole is grounded in design thinking, Kismet specifically extends Nonaka and Takeuchi's (1995) SECI model by providing a deliberate mechanism for tipping AI usage from the Combination phase into the Externalization phase. By prompting the AI to introduce surprising or lateral suggestions, the learner is forced to articulate previously tacit reactions to those suggestions - converting tacit unease, intuition, or excitement into explicit, defensible reasoning. This mechanism is distinctively positioned to develop the EntreComp 'Coping with ambiguity, uncertainty and risk' competence in adolescent learners, who otherwise tend to avoid ambiguous situations rather than engage with them productively.

5.4 Finding 4: A Validated Pathway from Simulation to Real Venture

The framework's developmental scaffolding (Panel C) creates an unbroken pathway from elementary play-based simulation through middle-school full SPARK cycles to high-school real venture launch. This is consistent with NFTE's documented progression model (Network for Teaching Entrepreneurship, 2024) and Junior Achievement USA's K-5 through high-school programme architecture (Junior Achievement USA, 2024). The presence of validated assessment instruments at each stage - the AEA scale (Liu et al., 2024) for K-12 generally, the BEPE-A (Postigo et al., 2021) for adolescents, and the EntreComp self-assessment tool (Bacigalupo et al., 2016) for older students - means the framework is empirically auditable along its full developmental length.

5.5 Finding 5: A Mechanism for Equitable Access

The OECD (2024) finds that financial literacy attainment is strongly mediated by socio-economic status, with an 87-point average gap between advantaged and disadvantaged 15-year-olds across OECD countries. Aspen Institute (2008) argues that low-income U.S. youth often possess inherent 'business smarts' but lack institutional toolkits. By providing a virtual, resource-rich simulation environment, the SPARK-K12 Framework offers a partial mechanism for democratizing access. When paired with adequate broadband and device provision through Title I subsidies (see Section 6), it can level the simulation environment available to under-resourced students with that available in affluent districts.

5.6 Finding 6: Educator Efficiency Gains Free Capacity for Socialization

The Hunt Institute (2025) reports that generative AI can reduce K-12 lesson-planning time by approximately 31% (around 25 minutes per week). Within the SPARK-K12 Framework, this released educator capacity is deployed precisely where teachers add irreplaceable value: interpreting simulation analytics, distinguishing productive cognitive friction from destructive frustration, and facilitating the reflective Socialization conversations that convert simulated failure into long-term wisdom (Nonaka and Takeuchi, 1995). The framework, therefore, reframes the relationship between AI and the educator: AI handles Combination, the educator handles Socialization and Internalization, with neither displacing the other.

5.7 Finding 7: Direct Alignment with U.S. Macroeconomic Trends

Finally, the framework directly aligns with the empirical macroeconomic trends documented in Section 1. The U.S. is experiencing record entrepreneurial activity (5.4 million new applications in 2023; U.S. Census Bureau, 2025), led demographically by 18-24-year-olds (Babson College, 2025). The K-12 cohort entering this environment will need precisely the integrated entrepreneurial-and-AI competence package the framework cultivates. Conceptually, then, the framework is positioned to translate downward into the K-12 system the very economic dynamism that GEM and BFS data show emerging in early adulthood.

Table 2: Conceptual Findings, Mechanisms and Supporting Evidence

#	Finding	Mechanism	Key Evidence
1	Concurrent cultivation of entrepreneurial and AI literacy competences	SPARK phases activate EntreComp + Long & Magerko competences simultaneously	Bacigalupo et al. (2016); Long & Magerko (2020)
2	SPARK preserves student agency in AI-augmented learning	Pre-prompt scaffolding requires articulation before invocation	Quidwai (2023); EdTech Digest (2026)
3	Kismet bridges AI Combination and human Externalisation	Lateral prompts force articulation of tacit reactions	Nonaka & Takeuchi (1995); Quidwai (2023)
4	Validated pathway from simulation to real venture	Three-stage K-12 scaffolding aligned with EntreComp 8-level model	NFTE (2024); JA USA (2024); Liu et al. (2024)
5	Mechanism for equitable access	Virtual high-fidelity environment substitutes for absent local mentors and resources	OECD (2024); Aspen Institute (2008)
6	Educator efficiency gains free capacity for Socialisation	AI handles Combination; educator handles tacit-knowledge phases	Hunt Institute (2025); Nonaka & Takeuchi (1995)
7	Direct alignment with U.S. macroeconomic trends	K-12 pipeline mirrors documented 18-24 entrepreneurial surge	U.S. Census Bureau (2025); Babson College (2025)

6. Discussion

The SPARK-K12 Framework's conceptual integrity does not, by itself, guarantee successful implementation at scale. This section critically examines four implementation challenges, three ethical considerations, and a concrete five-point policy roadmap for systemic deployment in U.S. K-12 education.

6.1 The Institutional AI-Readiness Gap

U.S. K-12 institutional capacity to deploy AI-driven simulations is fragmented. The Hunt Institute (2025) and EdTech Digest (2026) document that 58% of educators have received no formal AI professional development, that 62% cite limited training opportunities as an operational hazard, and that funding was named the largest unmet ed-tech need by state leaders in 2025. The expiration of Elementary and Secondary School Emergency Relief (ESSER) funds has further constrained district capacity, forcing trade-offs between advanced ed-tech investment and basic operational sustainability (Utah State Board of Education, 2025). For the framework to scale, schools must shift away from isolated do-it-yourself AI deployment toward coordinated infrastructure investments leveraging public-private partnerships - an approach demonstrated by NFTE and Junior Achievement USA at a smaller scale (Network for Teaching Entrepreneurship, 2024; Junior Achievement USA, 2024).

6.2 The Digital Divide

AI-driven simulations are computationally intensive and bandwidth-dependent. Students in rural and low-income communities frequently lack the broadband or hardware required for cloud-based generative simulations (Hunt Institute, 2025). If left unchecked, AI deployment will not democratize entrepreneurship education but exacerbate existing inequities - effectively encoding the OECD's documented 87-point socio-economic gap (OECD, 2024) into the next generation. Targeted Title I subsidies for both connectivity and AI-simulation platform licenses are essential.

6.3 Algorithmic Bias

Large language models are trained on historical business and financial datasets that embed systemic biases regarding gender, race and geography (UNESCO, 2024). If a simulation disproportionately rewards strategies that historically favored dominant demographics, or if AI customer avatars react negatively to products designed for marginalized communities, the simulation inadvertently encodes exclusionary practices into the formative cognitive habits of young entrepreneurs. Long and Magerko's (2020) AI literacy framework partially addresses this through the 'How Should AI be Used?' competency, but ed-tech vendors must be required to undertake routine third-party bias audits and to incorporate culturally responsive market scenarios. Notably, the SPARK Framework itself contributes to mitigation: by requiring students to articulate Problem and Aspiration in their own words, the framework forces them to overlay their own ethical and community context onto the AI's output (Quidwai, 2023).

6.4 The Ethical Risks of Digital Kidpreneurship

As digital monetization mechanisms become more accessible, the ethical implications of kidpreneurship require explicit pedagogical attention. Children operating in the digital economy may face unmanaged psychological pressure to generate income, leading to academic disruption, anxiety and burnout (Money and Pensions Service, 2024). The Money and Pensions Service (2024) literature review on digital money explicitly documents the gamification of speculative financial behavior and exposure to online fraud as material risks. Entrepreneurship education within the formal K-12 sphere must therefore explicitly decouple the learning of business mechanics from the high-pressure pursuit of real-world capital. The pedagogical value of an AI-driven BSG lies precisely in its status as a sandbox: it simulates the pressures of venture management without the devastating real-world stakes (Garris, Ahlers and Driskell, 2002), and educators must use debriefing phases to foster discussions on social impact, data privacy, and responsible marketing.

6.5 The Human-in-the-Loop Imperative

It is paramount to recognize the epistemological limits of AI within education. Nonaka and Takeuchi's (1995) SECI model is unambiguous: AI excels at the Combination of explicit knowledge but cannot substitute for the Socialization and Internalization processes required for tacit-knowledge formation. AI fundamentally lacks empathy, moral discernment and the shared experience of human vulnerability. The SPARK Framework structurally enforces a human-in-the-loop methodology: technology elevates human agency rather than replacing it (Quidwai, 2023). The K-12 educator's role, therefore remains indispensable. Teachers must transition from primary information-dispensers to learning architects and cognitive coaches, interpreting simulation analytics and guiding the reflective conversations that convert simulated failure into wisdom. The framework's adoption will require corresponding shifts in pre-service teacher education.

6.6 Policy Roadmap

Five concrete policy recommendations emerge from this synthesis:

- Federal funding alignment: update the Carl D. Perkins Career and Technical Education Act and the Workforce Innovation and Opportunity Act to include 'entrepreneurial literacy' and 'AI literacy' as essential 21st-century competencies, unlocking targeted federal funding for SPARK-K12 implementation.
- Modernized teacher professional development: replace one-off AI workshops with year-long Innovative Leadership Lab cohorts integrating design thinking, the SPARK Framework, and AI-based pedagogy. Such cohorts should be eligible for Title II ESEA funds.
- Title I AI-equity subsidies: targeted federal grants to subsidize both AI-simulation platform licenses and high-bandwidth connectivity in Title I schools, preventing the monopolization of advanced entrepreneurship education by affluent districts.
- Bias-audit mandates: federal-level mandates requiring annual third-party algorithmic-bias audits for any AI tool deployed in K-12 entrepreneurship education, modelled on emerging EU AI Act provisions.
- Cross-sector partnership infrastructure: formalize standing partnerships between school districts, NFTE, Junior Achievement, Babson's GEM team, and local employers to provide real-world feedback channels, mentorship, and pitch-competition pipelines for student simulations.

7. Conclusion and Future Research Agenda

7.1 Synthesis

The convergence of advanced AI capabilities, the macroeconomic necessity for durable skills, and the rising tide of youth entrepreneurial ambition presents the United States with a singular opportunity to redesign K-12 education. This conceptual synthesis demonstrates that traditional, passive modes of business education - reliant on static case studies and delayed feedback - are insufficient to prepare students for the complexities of an AI-augmented economy. The SPARK-K12 Framework, by integrating Quidwai's (2023) human-centered prompting routine with AI-driven Business Simulation Games and grounding the integration in five validated theoretical traditions (Kolb, 1984; Ajzen, 1991; Nonaka and Takeuchi, 1995; Bacigalupo et al., 2016; Long and Magerko, 2020), offers a scalable, ethical and human-centered blueprint for cultivating American kidpreneurship.

Through the structured sequence of Situation, Problem, Aspiration, Results and Kismet - mapped across SECI knowledge phases, EntreComp competence areas, AI literacy competencies, and a developmental K-12 scaffolding pathway - young learners can safely navigate the ambiguities of venture creation. They can practice empathetic customer discovery, master financial analytics and build the intellectual resilience required to survive market shocks, while concurrently developing the AI literacy that twenty-first-century citizenship demands.

7.2 Limitations

Three limitations of the present paper warrant explicit acknowledgement. First, as a conceptual synthesis (Jaakkola, 2020), the paper does not present primary empirical data; the propositions advanced in Section 5 require empirical validation. Second, the framework is calibrated to the U.S. K-12 context, and its transferability to other national systems requires further analysis. Third, the rapid pace of generative AI development means that specific tool implementations referenced here will require continual updating, although the underlying conceptual architecture is intended to remain stable.

7.3 Empirical Validation Agenda

The framework generates a structured empirical agenda. Priority studies include:

- Quasi-experimental validation: pre-post studies comparing SPARK-AI BSG cohorts with traditionally instructed control groups across grades 6-12, using validated instruments (AEA scale; BEPE-A; EntreComp self-assessment; NFTE Entrepreneurial Mindset Index) and the methodological designs documented by Sheikh et al. (2025) and Conner, Roberts and Stripling (2022).
- Longitudinal tracking: cohort studies tracking the transition from K-12 SPARK participation through college and into early-career entrepreneurial activity, benchmarked against GEM Total Entrepreneurial Activity statistics (Babson College, 2025).

- Equity-outcome studies: comparative analyses of SPARK implementation outcomes between Title I and non-Title I schools, addressing the 87-point OECD socio-economic gap (OECD, 2024).
- Algorithmic-bias audits: independent third-party audits of deployed simulation engines, evaluating for gender, race and geographic biases in AI-generated customer personas, market dynamics and feedback patterns.
- Teacher-readiness studies: mixed-methods investigation of pre-service and in-service educator preparation needs, addressing the 58% AI training gap documented by the Hunt Institute (2025).

Only through this multi-track empirical programme can the conceptual promise of the SPARK-K12 Framework be fully realized. By prioritizing human-centred design, robust ethics and equitable access, the U.S. educational system can cultivate a diverse generation of kidpreneurs equipped with the durable, creative and empathetic skills necessary to drive sustainable economic growth in the twenty-first century.

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