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A responsive and agentic artificial intelligence-driven online learning framework for personalized digital competency development among digital industry entrepreneurs

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Abstract

Purpose – This study aimed to develop and evaluate an innovative online learning management model designed to enhance digital literacy competencies among entrepreneurs in the digital industry. Grounded in work-integrated learning (WIL) principles and coaching approaches, the model further integrates agentic artificial intelligence to provide adaptive and personalized learning experiences aligned with entrepreneurial demands.

Design/methodology/approach – A four-phase research and development (R&D) methodology was employed. Phase one reviewed literature to identify essential model components. Phase two involved model design, integrating a responsive online platform, digital design tools, WIL and coaching. Phase three implemented the model with 43 entrepreneurs in Thailand's New Generation Graduates Project, comprising 60 h of theoretical instruction and 225 h of workplace practice over a 12-week period. Phase four enhanced the model through the integration of agentic AI. Data collection included pre- and post-tests, authentic competency rubrics and satisfaction surveys. Analysis employed descriptive statistics, dependent *t*-tests ($p < 0.05$) and content analysis.

Findings – Results indicated statistically significant improvements in digital literacy. Post-test scores ($M = 59.19$, $SD = 7.01$) were substantially higher than pre-test scores ($M = 36.51$, $SD = 10.65$). Participants achieved competency at a good level, with over 60% reporting tangible entrepreneurial benefits, including increased sales, expanded customer bases and stronger competitive positioning. The integration of theoretical instruction, authentic workplace applications and personalized coaching was found to be effective, while the AI-enhanced strategy demonstrated potential for delivering adaptive, learner-centered experiences responsive to individual needs and industry contexts.

Practical implications – The model presents a practical solution for educators, policymakers and training providers seeking to strengthen digital literacy among entrepreneurs. Its integration of workplace learning, coaching and adaptive AI demonstrates a scalable pathway for enhancing entrepreneurial capacity in rapidly evolving digital economies. Adoption of this framework can inform curriculum design, workforce development initiatives and digital upskilling programs, ensuring alignment between learner needs and industry requirements. Furthermore, the responsive nature of the AI-enhanced framework allows for continuous adaptation, supporting sustainable entrepreneurial growth and competitiveness in dynamic business environments.

Originality/value – The study contributes originality by synthesizing WIL, coaching and agentic artificial intelligence into a unified online learning management framework. Unlike conventional digital literacy interventions, the model bridges academic theory with entrepreneurial practice while leveraging AI for personalization and scalability. Its empirical validation with entrepreneurs provides both theoretical and practical value, offering a replicable framework for cultivating future-ready digital competencies and fostering entrepreneurial success in technology-driven marketplaces.

Keywords Digital literacy, Work-integrated learning, Digital industry entrepreneurs, Personalized learning, Agentic artificial intelligence, Entrepreneurship education

Paper type Research article

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Introduction

The contemporary global economy is undergoing an unprecedented transformation driven by accelerated digitalization, fundamentally reshaping entrepreneurial landscapes and redefining the competencies required for business success. Digital technologies have evolved beyond traditional role as operational tools to become central determinants of competitive advantage, market access, and organizational sustainability. This paradigmatic shift has created an urgent need for entrepreneurs to cultivate advanced digital literacy—extending beyond basic technological skills to include strategic digital thinking, data-informed decision-making, and adaptive innovation.

Traditional models of entrepreneurship education have demonstrated significant limitations in addressing these evolving competency demands. Conventional learning management systems primarily highlight theoretical knowledge delivery through standardized curricula that fail to reflect the dynamic and context-specific nature of today's digital business environments. Consequently, these models fall short in preparing entrepreneurs to meet the challenges of digital transformation—particularly in acquiring practical skills in areas such as digital marketing optimization, e-commerce platform management, and the application of data analytics. The disconnect between academic instruction and real-world digital business practices has contributed to a considerable competency gap, undermining entrepreneurial effectiveness in technology-driven markets.

Recent scholarship has identified work-integrated learning (WIL) as a promising pedagogical strategy for bridging theory-practice divides in professional education. WIL creates structured opportunities for learners to apply theoretical knowledge within authentic workplace contexts while developing practical competencies through guided experience. When integrated with personalized coaching methodologies, this framework allows individualized skill development that responds to specific learner needs and business contexts. Nonetheless, existing implementations of WIL in entrepreneurship education have not adequately incorporated digital technologies to optimize personalization, responsiveness, and adaptive learning delivery.

The emergence of agentic artificial intelligence (AI) technologies presents unprecedented opportunities to transform educational delivery through intelligent personalization and adaptive content curation. Agentic AI systems possess autonomous reasoning capabilities that enable the dynamic assessment of individual learning needs, real-time adjustment of instructional approaches, and continuous optimization of learning pathways based on performance analytics. These capabilities are particularly well suited to entrepreneurial learning, where learners often exhibit diverse technological backgrounds, operate within varied business contexts, and require individualized competency development—factors that challenge standardized educational models.

Thailand's digital economy development efforts—exemplified by the Thailand 4.0 policy framework—have underscored the significance of cultivating advanced digital competencies within the entrepreneurial workforce. The New Generation Graduates Project, supported by the Ministry of Higher Education, Science, Research, and Innovation, represents a strategic investment in cultivating digital industry expertise to support national economic competitiveness. This policy environment provides a compelling backdrop for exploring innovative educational models capable of effectively building the digital literacy competencies essential for entrepreneurial success in emerging digital economies.

Despite growing recognition of both the educational challenges and technological opportunities in digital entrepreneurship, limited empirical research has explored the integration of WIL, personalized coaching, and agentic AI technologies within comprehensive frameworks. Existing studies have primarily prioritized individual components rather than the systematic integration of multiple pedagogical and technological approaches. This research gap hinders the development of evidence-based educational models that can effectively address the complex, multifaceted nature of digital competency development for entrepreneurs operating in rapidly evolving technological environments.

This research addresses these limitations by developing and evaluating an innovative online learning management framework that systematically integrates WIL principles with personalized coaching approaches to optimize digital literacy competencies among digital industry entrepreneurs. Building on empirical findings from the model's implementation, the study further proposes a Responsive Agentic AI-Enhanced Learning Framework—a scalable, adaptive solution for personalized digital competency development that dynamically responds to individual learner profiles and shifting industry demands.

The study investigates four primary research questions, targeting both the immediate educational impact and the long-term potential of AI integration in entrepreneurship education:

(1) What essential elements and processes are required to develop an effective online learning management model that combines work-integrated education and personalized coaching to promote digital literacy among digital industry entrepreneurs?

(2) To what extent does the implementation of this model enhance digital literacy skills and learning achievement among participating entrepreneurs?

(3) What levels of satisfaction do participants report regarding this integrated educational approach?

(4) What architectural components are necessary for designing a responsive agentic AI online learning framework that supports personalized digital competency development for digital industry entrepreneurs?

These research questions collectively address the critical need for evidence-based educational models that can effectively prepare entrepreneurs for success in increasingly digitalized business environments while establishing theoretical foundations for future integration of advanced AI technologies in entrepreneurship education. The work contributes to both practical educational development and theoretical advancement in understanding how integrated pedagogical approaches can optimize professional competency development in technology-intensive domains.

Literature review

Digital literacy in entrepreneurial contexts

Digital literacy represents a multifaceted competency framework that extends beyond basic technological proficiency to include critical thinking, creative problem-solving, and strategic application of digital tools in professional contexts. Contemporary definitions highlight the ability to access, evaluate, integrate, and create digital content while maintaining ethical awareness and responsible technology use (UNESCO, 2018). This conceptualization has evolved significantly from early computer literacy models, demonstrating the increasing sophistication of digital technologies and their integration into business operations.

Entrepreneurship research highlights that digital literacy competencies directly correlate with venture performance and market competitiveness. Mohamad *et al*. (2025) affirmed that digital literacy empowers entrepreneurs to leverage digital platforms for data-driven decision-making, strategic marketing, and adaptive operations, which are necessary for sustaining growth in digital economies. Additionally, digital literacy equips entrepreneurs with capabilities to adopt emerging technologies such as AI, big data analytics, and subscription-based models that foster innovation, customer-centric personalization, and global scalability (Agarwal, 2024). By integrating technological fluency with entrepreneurial acumen, businesses can navigate complex digital markets and secure sustainable competitive advantages.

Nonetheless, a significant gap remains between current digital literacy and the practical application needs of entrepreneurs. Traditional strategies tend to center on tool-specific

training rather than the development of adaptive, personalized digital competencies that allow entrepreneurs to effectively leverage emerging technologies. This limitation becomes increasingly critical in rapidly evolving digital environments, where platforms and tools evolve rapidly. Entrepreneurs, therefore, must develop foundational, transferable digital skills that can be continuously applied across a range of technological contexts.

Work-integrated learning in professional education

WIL has emerged as a pedagogical strategy that addresses persistent theory-practice gaps in professional education by systematically integrating academic study with authentic workplace experience. The conceptual foundation of WIL rests on experiential learning theory, which proposes that meaningful learning occurs through reflection on direct experience rather than passive knowledge absorption (Kolb, 2014). Contemporary implementations underscore structured integration between academic institutions and industry partners to create learning environments that develop both theoretical understanding and practical competency.

Empirical research consistently exhibits positive outcomes from WIL implementations across diverse professional domains. For instance, Jackson and Dean (2022) conducted a cross-sectional study showing that students engaged in WIL programs exhibited significantly higher levels of employability skills, professional confidence, and career clarity compared to those in traditional classroom-only settings. These benefits extend beyond individual outcomes to organizational performance, with participating employers reporting enhanced innovation capacity and stronger industry-academic partnerships.

Nevertheless, WIL implementation encounters substantial hurdles that restrict its effectiveness in developing specialized competencies such as digital literacy. Coordination complexity between academic and industry partners typically leads to misaligned learning objectives and inconsistent quality standards (Jackson *et al*., 2021; Kligyte *et al*., 2023). Additionally, traditional WIL models frequently fall short in addressing the personalized learning needs inherent in entrepreneurial development, where learners bring diverse backgrounds, varied learning preferences, and unique business contexts that resist standardized educational approaches.

Coaching methodologies in entrepreneurial development

Professional coaching has gained recognition as an effective intervention for entrepreneurial development, distinguished from traditional advisory relationships through its emphasis on guided self-discovery rather than directive consultation. Its theoretical foundation is rooted in adult learning principles and cognitive–behavioral frameworks, which underscore individual agency in problem-solving and goal achievement (Karlsen and Berg, 2020). Contemporary coaching models integrate structured questioning techniques, reflective practices, and accountability mechanisms to support autonomous learning and professional growth.

Research evidence supports coaching effectiveness in entrepreneurial contexts across multiple performance dimensions. Studies have shown that entrepreneurs who participate in structured coaching programs achieve significantly better business outcomes—including improved decision-making, more efficient resource allocation, and greater resilience during market fluctuations—compared with control groups receiving traditional business support services (Kotte *et al*., 2021; van Coller-Peter and Cronjé, 2020). These benefits appear particularly pronounced for early-stage entrepreneurs who lack extensive business experience and professional networks.

Nonetheless, implementing coaching processes for entrepreneurs encounters considerable hurdles across stakeholder, procedural, and contextual dimensions. Traditional one-to-one coaching demands extensive resources, thereby restricting access and constraining the ability to address authentic entrepreneurial needs comprehensively. Coachees may resist change, fear uncertain outcomes, or lack trust in the coaching process, while entrepreneurs' demanding schedules often hinder their ability to commit sufficient time to structured sessions.

Additionally, some coaches may possess limited experience, consequently hindering their capacity to customize interventions according to personalized requirements. Nevertheless, collaborative design and strategic planning of personalized coaching frameworks can systematically identify strengths, weaknesses, and motivational drivers through continuous assessment (Kotte *et al*., 2021; van Coller-Peter and Cronjé, 2020). This strategy allows coaches to offer targeted guidance while facilitating coachees' self-reflection, ultimately enabling participants to develop contextually relevant self-improvement strategies that constitute a dynamic and effective methodology for fostering comprehensive personalized and venture-level development (Grover and Furnham, 2016).

AI applications in personalized learning

The emergence of AI technologies has created unprecedented opportunities for personalized learning delivery through intelligent content adaptation, real-time performance assessment, and dynamic learning pathway optimization. Agentic AI systems represent a major advancement in this domain, characterized by autonomous reasoning capabilities that allow proactive adaptation to individual learning needs without continuous human oversight (Murugesan, 2025). These systems incorporate natural language processing, predictive analytics, and adaptive content delivery to create responsive learning environments tailored to learners' unique characteristics and performance patterns.

Educational applications of agentic AI exhibit promising potential in overcoming the personalization limitations inherent in traditional learning management systems. For instance, Zhang (2024) implemented an AI-enhanced learning platform that achieved improvement in learning outcomes compared with conventional online learning approaches through dynamic content sequencing and personalized feedback mechanisms. Similarly, AI-powered adaptive assessment systems facilitate continuous competency evaluation, delivering detailed insights into individual skill development pathways and learning progression patterns (Hamal *et al*., 2022).

Despite technological advances, considerable hurdles restrict widespread adoption of AI-enhanced learning systems in professional education contexts. Algorithmic transparency concerns, data privacy implications, and ethical considerations concerning automated decision-making necessitate careful consideration when implementing AI systems in educational settings (Bakir *et al*., 2025; Hamal *et al*., 2022). Additionally, the complexity of integrating AI technologies with existing educational infrastructure commonly exceeds institutional technical capabilities, creating implementation barriers for several educational organizations.

Research gaps and theoretical implications

The literature review reveals several critical gaps that restrict current understanding of effective digital entrepreneurship education. First, limited research explores how WIL principles can be adapted specifically for digital literacy development, specifically in entrepreneurial contexts where learning objectives highlight strategic application rather than technical mastery. Second, there is insufficient empirical evidence regarding the optimal integration of coaching methodologies with technology-enhanced learning delivery, particularly in terms of scalability and quality assurance considerations.

Third, while AI applications in education demonstrate significant potential, few studies have explored how agentic AI systems can be specifically designed to meet the unique learning needs of entrepreneurs, which differ markedly from traditional academic learning objectives. Fourth, existing studies lack comprehensive evaluation frameworks that assess both immediate learning outcomes and longer-term business impacts. This limitation hampers a comprehensive understanding of the effectiveness of educational program in cultivating sustainable entrepreneurial capabilities.

These gaps collectively constrain the development of evidence-based educational models that can effectively prepare entrepreneurs for success in rapidly evolving digital business

environments. The integration of WIL, personalized coaching, and agentic AI technologies represents a promising approach for addressing these limitations. Nonetheless, systematic empirical investigation is necessary to validate its effectiveness and identify optimal implementation strategies across diverse entrepreneurial populations and educational contexts.

Conceptual framework

The diagram (Figure 1) depicts how systematic literature on design tools, coaching, and work-integrated learning is integrated into an AI platform to develop entrepreneurs' digital literacy competency.

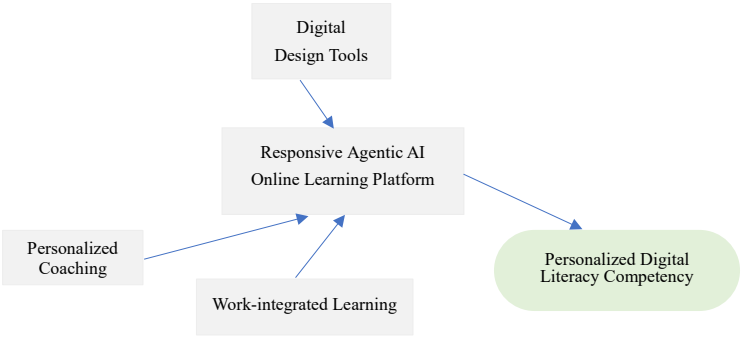

Figure 1. Systematic literature on entrepreneur's digital literacy competency

Methodology

Research design

This research and development study employed a systematic four-phase approach to develop and evaluate an innovative online learning framework. The first phase encompassed conducting comprehensive literature reviews to examine the existing components of online learning management models that integrate work-based education and coaching principles for optimizing digital literacy among industry entrepreneurs. In the second phase, these findings informed the design and development of a novel learning management model tailored to address identified gaps and opportunities. The third phase encompassed experimental intervention studies to explore the model's appropriateness and effectiveness in enhancing digital learning competencies among target participants. The final phase culminated in the proposal of a responsive agentic AI online learning framework that synthesizes WIL concepts, digital tools, and coaching approaches to deliver personalized digital competency development for entrepreneurs operating within the contemporary technological landscape.

Participants

The research centered on digital industry entrepreneurs formally enrolled in Thailand's "New Generation Graduates Project," an initiative designed to support the country's Higher Education Reform Policy objectives. All participants were registered in the Non-Degree Certificate program within the Digital Industry Management curriculum, specifically targeting professionals engaged in digital industry sectors. Through purposive sampling, 43 participants were recruited on a voluntary basis. This sampling approach guaranteed the inclusion of individuals with demonstrated industry experience and genuine commitment to optimizing their digital competencies within the structured framework of this government-supported workforce development program.

Research study

This research employed a systematic research methodology structured across four distinct phases, with instrument development adhering to established empirical research standards.

Phase 1: development of the online learning management model

The development of an online learning management model integrating work-based education principles and coaching approaches to optimize digital literacy among digital industry entrepreneurs followed the ADDIE Model framework through five systematic steps.

The Analysis Phase encompassed comprehensive document reviews and research analysis to establish learning management model goals, define specific objectives, determine learning environment requirements, and assess learners' foundational knowledge and existing digital literacy competencies.

During the Design Phase, empirical findings from the document review and research analysis informed the development of a learning management model integrating four integrated components. The responsive online learning platform offers a versatile interface supporting accessibility across multiple devices. Digital design tools function as strategic instruments for content creation and management. WIL components facilitate the application of theoretical knowledge within authentic workplace contexts. Coaching mechanisms deliver personalized guidance and structured feedback processes.

The Design Phase addressed three critical areas. Online learning units included asynchronous video content for theoretical instruction, designed to accommodate flexible learning schedules. These were complemented by 60 h of synchronous practical activities and 225 h of workplace application. This was further supported by comprehensive coaching that encompassed consultation, supervision, monitoring, and assessment. The responsive online learning platform established a responsive system optimized for desktop computers, personal computers, smartphones, and mobile devices across all operating systems, incorporating touchscreen interaction capabilities. The learning assessment framework emerged through systematic document analysis aligned with learning objectives, leading to appropriate testing instruments and activities to examine fundamental knowledge and digital literacy competencies.

The Development Phase involved constructing the learning management model according to specified components while implementing verification protocols to guarantee accuracy and completeness. During the Implementation Phase, the preliminary online learning management model underwent testing with participants whose characteristics aligned with the target sample group, with feedback informing subsequent refinements. The Evaluation Phase encompassed the revision and enhancement of both the learning management model and corresponding learning plans in preparation for comprehensive implementation.

Phase 2: implementation result study

The finalized online learning management framework was implemented with 43 digital industry entrepreneurs over a three-month period. This phase focused on collecting and analyzing implementation outcomes to assess overall effectiveness and determine the extent to which the specified learning objectives were achieved.

Phase 3: satisfaction assessment

This phase examined participant satisfaction with the online learning management framework based on work-integrated education and coaching principles designed to optimize digital literacy competencies among digital industry entrepreneurs. Assessment prioritized user experience, perceived value, and overall program effectiveness from the participant's perspective.

Phase 4: model proposal development

This phase encompasses proposing a responsive agentic AI online learning framework that integrates WIL concepts, digital tools, and personalized coaching approaches to foster

personalized digital competencies for industry entrepreneurs. This model synthesizes research findings into an adaptive framework specifically addressing the unique challenges of digital entrepreneurship within today's rapidly evolving technological landscape.

Instrumentation

This research employed five carefully designed instruments to ensure comprehensive data collection and rigorous analysis throughout the study.

(1) The Learning Plans functioned as structured frameworks aligned with the developed learning model and covered seven key content areas: (1) digital literacy fundamentals, (2) digital marketing strategies and content calendar development, (3) branding and content marketing approaches, (4) business graphic design using Canva, (5) Facebook advertising and digital tool implementation, (6) search engine marketing techniques, and (7) business website creation using WordPress and Element or Pro.

(2) The Learning Achievement Test comprised a comprehensive assessment instrument containing 70 multiple-choice questions, each presenting four response options to participants. This test underwent rigorous expert validation conducted by three specialists in the field, leading to an Index of Item-Objective Congruence ranging from 0.60 to 1.00. These values affirmed the validity of all test items and established their appropriateness for research implementation.

(3) Designed as an authentic performance-based evaluation, the Digital Literacy Competency Assessment assigned practical tasks assessed through a structured four-level rubric. It measured five core competency domains: access, manage, integrate, evaluate, and create. Three expert validators reviewed this instrument and established IOC values ranging from 0.60 to 1.00, thereby verifying its suitability for measuring target competencies.

(4) The Satisfaction Assessment Form utilized a five-point Likert scale—ranging from "lowest" to "highest"—to measure participant satisfaction with the learning management model. Expert validation conducted by three specialists yielded an IOC value of 1.00, indicating excellent content validity and confirming the instrument's reliability for capturing participant perspectives.

(5) The responsive online learning platform represented a comprehensive e-learning system featuring responsive design architecture to guarantee cross-device compatibility across desktop computers, personal computers, smartphones, and mobile devices operating on all major systems. It integrated online media resources, comprehensive information databases, sophisticated assessment tools, interactive exercises, advanced tracking systems, and structured workshop components. Three expert evaluators assessed the platform's functionality and pedagogical appropriateness, validating its suitability with an IOC value of 1.00, which exhibited complete alignment with research objectives and technical requirements.

Data analysis and statistical methods

The analytical framework leveraged comprehensive statistical procedures and analytical techniques specifically aligned with the mixed-methods research design and research questions that guided this investigation. Quantitative data analysis procedures were structured to establish statistical evidence of improvement in learning, while qualitative analysis approaches offered essential contextual insights into participant experiences and satisfaction throughout the intervention.

Pre-post learning achievement data underwent rigorous analysis utilizing paired-samples *t*-tests at the 0.05 significance level to determine statistically significant differences in

knowledge acquisition following intervention completion. Prior to the *t*-tests, data were systematically explored for normality assumptions using the Shapiro–Wilk test, with additional examination of skewness and kurtosis statistics to validate the appropriateness of parametric statistical procedures.

Digital literacy competency assessments were explored using descriptive statistical measures, encompassing means and standard deviations, to characterize participant performance across the five competency domains of access, manage, integrate, evaluate, and create. The authentic assessment rubric scores underwent detailed examination to identify patterns of strength and areas necessitating additional development support within the participant group.

Satisfaction survey data collected through the five-level Likert scale instruments were analyzed using descriptive statistics to determine central tendencies and variability across satisfaction dimensions. Mean satisfaction scores and standard deviations were calculated for overall satisfaction and for specific components, encompassing curriculum quality, instructor effectiveness, technical platform functionality, and support services. These analyses offered comprehensive insights into participant perceptions and identified areas of particular strength in the learning model's implementation.

An online learning management model based on WIL integrated with coaching to foster Digital Literacy Competency for digital industry entrepreneurs

The innovative learning model (Figure 2) integrates WIL principles with coaching approaches to foster digital literacy skills among digital industry entrepreneurs. This comprehensive framework encompasses four core components that work synergistically to deliver effective

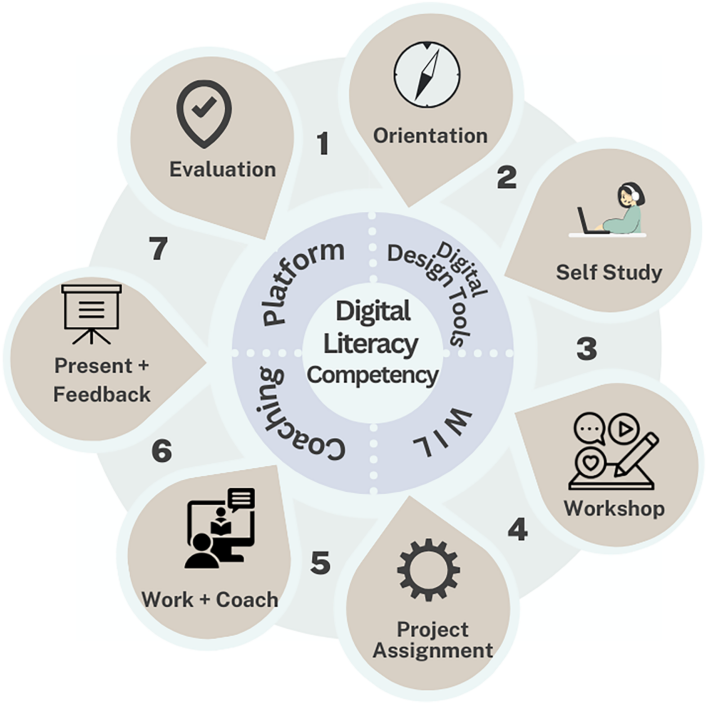

Figure 2. A responsive online learning management model

learning outcomes. The responsive online learning platform offers responsive online learning materials, resources, and content modules accessible across numerous devices and operating systems. Digital design tools offer strategic instruments for content creation and management, allowing practical skill application. WIL components facilitate the application of theoretical knowledge within authentic workplace contexts. Coaching mechanisms deliver personalized guidance, supervision, and structured feedback processes throughout the learning journey.

The model implementation spans a 12-week period, integrating 60 h of theoretical instruction and 225 h of practical training. This structured framework guarantees comprehensive skill development through both conceptual understanding and hands-on application. The learning process follows seven sequential steps designed to progressively build competencies while maintaining participant engagement and learning effectiveness.

Step 1: Orientation prepares learners for the course through comprehensive introduction sessions, encompassing pre-learning knowledge assessments to establish baseline understanding and identify individual learning needs. This foundational phase ensures that all participants begin with clear expectations and appropriate preparation for the learning journey ahead.

Step 2: Self-paced study through the online platform allows learners to engage in self-directed learning utilizing multimedia resources such as instructional videos, comprehensive manuals, and content summary activities. This phase occurs during weeks 1, 2, 3, and 7, offering flexibility for diverse learning schedules and individual preferences while ensuring thorough coverage of foundational theoretical concepts.

Step 3: Synchronous online workshops facilitate scheduled interactive sessions where learners engage in collaborative learning experiences. These sessions begin with a structured review of multimedia-based content, followed by the introduction of new concepts and collaborative discussions that encourage reflection and adaptation of understanding. Learners engage in practice tasks tailored to their individual learning contexts while obtaining real-time instructor feedback throughout weeks 4–6.

Step 4: Project-based learning comprises instructor-assigned tasks that necessitate learners to apply acquired knowledge to solve problems in authentic contexts. Learners obtain continuous guidance and formative feedback as they design, develop, and refine their projects during weeks 7–10. This phase bridges theoretical learning with practical application, ensuring effective knowledge transfer to real-world scenarios.

Step 5: Workplace learning and coaching constitute the practical training component, wherein learners engage in professional development within established business environments. Guided by ongoing coaching from instructors, learners apply their skills in real-world scenarios while receiving continuous supervision, consultation, and performance evaluation during weeks 8–12. This phase guarantees authentic skill application and professional competency development within actual industry contexts.

Step 6: Presentation and feedback sessions reconvene learners in synchronous online environments to present their project outcomes and obtain constructive feedback. These presentations occur during weeks 11 and 12, with instructor feedback aimed at reinforcing strengths and identifying areas for continued improvement. This phase consolidates learning experiences and fosters reflective practice through peer and instructor evaluation.

Step 7: The final evaluation involves comprehensive assessment of learner outcomes based on established criteria to measure performance and achievement across all competency domains. Instructors employ multiple assessment strategies to guarantee a thorough evaluation of both theoretical understanding and practical skill application, thereby offering detailed documentation of each participant's learning progress and competency attainment throughout the program.

Results

Learning achievement

The pre-post assessment analysis exhibited considerable improvements in learning outcomes following participation in the online learning strategy that integrated WIL with coaching strategies for digital literacy development among digital industry entrepreneurs. Participants attained substantially higher post-test scores, with a mean of 59.19 and a standard deviation of 7.01, compared with their pre-test scores, which had a mean of 36.51 and a standard deviation of 10.65. This difference reached statistical significance at the 0.05 level (Table 1), demonstrating meaningful knowledge acquisition and skill development through the implemented learning model.

The marked improvement in scores reflects effective learning transfer, while the reduced standard deviation in post-test results proposes more consistent learning outcomes across participants. This pattern indicates that the model successfully addressed various baseline knowledge levels and diverse learning needs within the participant group, exhibiting its adaptability and instructional effectiveness.

Digital Literacy Competency

An evaluation of participant-generated products following the completion of the online learning model displayed strong performance in digital literacy competencies across all assessment domains. Participants consistently showcased the ability to design deliverables that met specified assessment criteria, attaining an overall quality rating with a mean of 13.2 and a standard deviation of 0.67, indicating a high level of proficiency.

The relatively small standard deviation indicates consistent performance outcomes across the participant group, proposing that the integrated approach of WIL with coaching effectively supported uniform skill development among digital industry entrepreneurs. This finding confirms the model's instructional design and implementation methodology as an effective framework for professional competency development in digital business contexts.

Participant satisfaction

An analysis of participant satisfaction with the online learning model demonstrated exceptionally high overall satisfaction with a mean rating of 4.59 and a standard deviation of 0.58. A breakdown of specific satisfaction dimensions provided more profound insight into the model's effectiveness across various operational areas.

The curriculum, media, and training content attained the highest satisfaction rating with a mean of 4.77 and a standard deviation of 0.42, affirming strong participant approval of instructional materials and content design quality. Information delivery methods, instructor expertise, and instructor interpersonal qualities obtained equally high ratings with a mean of 4.72 and a standard deviation of 0.49. These findings underscore the critical role of both high-quality content and effective facilitation in creating a positive and engaging learning experience.

Service staff etiquette and responsiveness obtained notably high satisfaction ratings with a mean of 4.70 and a standard deviation of 0.50, while system functionality and intellectual tools

Table 1. Mean scores, standard deviations, and comparison of pre- and post-learning scores using the developed learning model

	Total score ($N = 43$)			
	M	*SD*	*t*-test	Sig.
Pre-learning	36.51	10.65	−12.69	0.00*
Post-learning	59.19	7.01		

Note(s): *$p < 0.05$

provided achieved a mean of 4.65 and a standard deviation of 0.47. Progress monitoring channels and feedback mechanisms were also well received, with a mean of 4.47 and a standard deviation of 0.75.

Training activity duration obtained the comparatively lowest satisfaction rating, though it maintained a high approval level with a mean of 4.00 and a standard deviation of 1.01. The larger standard deviation in this dimension proposes greater variability in participant preferences concerning time allocation, demonstrating an area for potential refinement in future model iterations.

These findings highlight the comprehensive effectiveness of the learning model design across numerous operational dimensions, specifically underscoring strengths in content development, instructor capabilities, and technical support systems. The consistently high ratings across all evaluated aspects validate the integrated approach taken in developing this online learning framework for digital literacy skill advancement among industry entrepreneurs.

A proposed responsive agentic AI online learning framework for optimizing personalized digital competencies in industry entrepreneurs

Recognizing the diverse technological proficiencies of learners, this research proposes a comprehensive responsive agentic AI online learning framework (Figure 3) that strategically integrates agentic AI, WIL, digital design tools, and personalized coaching to address the critical gap in adaptive digital competency development for industry entrepreneurs. The framework's distinctive contribution lies in its autonomous AI-driven personalization engine that continuously adapts learning pathways based on real-time performance analytics, integrated with authentic industry applications through embedded WIL components and data-informed coaching interventions. The systematic seven-step implementation process guarantees rigorous progression through orientation, self-paced adaptive study, synchronous online workshops, project-based assignments, industry-based application with personalized coaching, presentation and feedback, and comprehensive evaluation, thereby bridging the theory-practice divide that typically constrains traditional entrepreneurial education models.

The framework's theoretical foundation and empirical validation exhibit significant potential for transforming entrepreneurial digital education by offering scalable, personalized

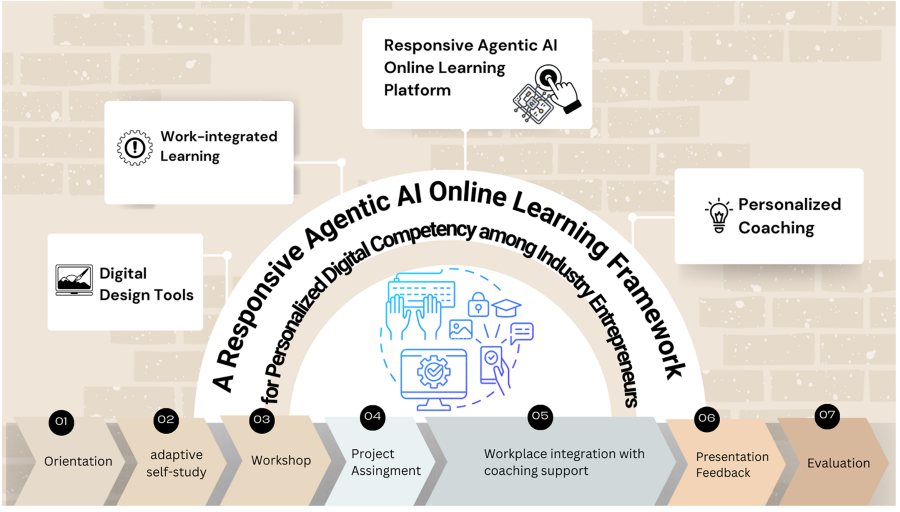

Figure 3. A responsive agentic AI online learning framework

learning experiences that respond dynamically to individual learner needs and industry demands. Each step in the process contributes to building cumulative digital competencies while maintaining authentic industry connections through WIL components and continuous coaching support. By fostering adaptive digital competencies through its integrated approach, the framework equips entrepreneurs to effectively navigate digital transformation hurdles while contributing to sustainable economic growth in increasingly digitalized business environments.

Future research should prioritize longitudinal impact assessment across all seven implementation phases, cross-cultural validation studies, and the framework's scalability across diverse entrepreneurial ecosystems to establish its broader applicability and effectiveness in optimizing personalized digital competency outcomes. The framework's structured approach offers a replicable model for institutions aiming at implementing comprehensive digital competency development programs that integrate technological innovation with human-centered pedagogical practices.

Discussion

Model components and implementation framework

The research outcomes affirm that the online learning management model based on WIL with coaching comprises four essential components that collectively promote digital literacy skills among entrepreneurs in the digital industry. The model incorporates a responsive online learning platform, specialized digital design tools, WIL methodologies, and structured coaching approaches within a comprehensive 12-week framework. The learning structure strategically allocates 60 h to theoretical knowledge acquisition while dedicating 225 h to practical application, underscoring the fundamental role of experiential learning in professional competency development.

The implementation process follows a systematic seven-phase progression encompassing orientation, platform-based content delivery, synchronous online engagement, contextually relevant project development, coached workplace integration, structured feedback mechanisms, and comprehensive assessment protocols. This structured strategy guarantees that participants advance through increasingly sophisticated applications of knowledge while obtaining targeted pedagogical support at each developmental stage.

The evaluation results exhibit exceptional effectiveness across all model components, with methodologies successfully supporting personalized active learning experiences. These outcomes align with established educational frameworks highlighting self-directed learning principles (Alsaadat, 2017; Knowles, 1984), evidence-based coaching methodologies (Grover and Furnham, 2016; Kotte *et al*., 2021; Toll, 2014; van Coller-Peter and Cronjé, 2020), and authentic work-based learning approaches (Office of the Education Council, 2009; Kramer and Usher, 2011). The integration of these elements results in a comprehensive framework that effectively cultivates the digital literacy competencies essential for entrepreneurial success in digital industries.

Empirical evidence for learning effectiveness

The empirical assessment offers compelling evidence of the model's educational effectiveness, as evidenced by statistically significant improvements in digital literacy proficiency. Participants demonstrated measurable enhancement in both knowledge achievement assessments and work product evaluations following program completion. These outcomes validate the model's ability to bridge theoretical instruction with practical application, empowering learners to convert educational content into workplace-ready skills.

The findings validate research by Sutthinan *et al.* (2021), which concluded that learning environments integrating digital media, structured processes, online platforms, and creativity-enhancing technologies effectively cultivate digital literacy competencies. The model's

success lies in its multifaceted structure, which combines systematic knowledge development with real-time application in authentic professional settings.

Qualitative data further reinforce the model's effectiveness. Ninety percent of participants reported successful knowledge transfer to their work environments. Participants demonstrated practical application through diverse digital outputs, encompassing marketing-focused graphic design, strategic marketing planning initiatives, website enhancement and development projects, and community knowledge transfer activities. These results align with findings by Nair and Mahalingam (2014), who highlighted that self-directed digital content creation and public dissemination via online platforms foster interactive engagement and enhance promotional capabilities. The model's effectiveness extends beyond individual skill development to create tangible business value and community impact, exhibiting its relevance for digital industry entrepreneurship.

Participant satisfaction and business impact

The evaluation of participant satisfaction demonstrated exceptionally high approval ratings, with 91.86% of learners reporting maximum satisfaction with the program. Participants specifically underscored the direct business relevance of acquired knowledge, stressing its immediate applicability to operational and developmental initiatives that optimized competitive positioning within their respective markets.

Quantitative business impact metrics verify these satisfaction perceptions, with over 60% of participants reporting measurable improvements across key performance indicators, encompassing increased sales volume, expanded customer acquisition, and investment growth, accompanied by concurrent reductions in operational costs. These results reflect the program's alignment with contemporary business requirements in an increasingly digitalized marketplace where online marketing serves as a critical channel and digital technologies function as essential business enablers.

The outcomes highlight the significance of developing comprehensive digital competencies, encompassing foundational digital literacy, proficient utilization of diverse digital tools, strategic technology selection, and adaptive capacity in response to rapid technological evolution. These competencies align with core requirements identified by the Office of the National Economic and Social Development Board (2016) for entrepreneurial success in digital economies.

Implementation challenges primarily centered on scheduling constraints, with approximately 30% of participants—predominantly business owners with significant time constraints—reporting difficulty with content pacing and adhering to designated study periods. To address these concerns, the research team introduced coaching interventions and program modifications grounded in adult learning principles. These included flexible scheduling, recognition of individual differences, collaborative dialogue that integrated participant perspectives and expectations, and support for self-directed learning (Alsaadat, 2017; Knowles, 1984; Sakcharoen, 2015).

Responsive program adjustments involved optimized scheduling flexibility, the implementation of participant-selected communication channels through web applications aligned with individual preferences and technical proficiencies, and the systematic collection of participant feedback to guide continuous program refinement.

Future directions and theoretical framework

Drawing from findings that highlight varying levels of technological proficiency among learners, this research presents a responsive agentic AI online learning framework that integrates AI, WIL, digital design tools, and personalized coaching to optimize the development of personalized digital competencies for industry entrepreneurs. The framework utilizes an AI-driven personalization engine that continuously adapts learning pathways based on real-time performance analytics, complemented by authentic industry applications through embedded WIL components.

The theoretical framework systematically bridges theory and practice through a seven-step implementation process, leveraging adaptive learning pathways and authentic industry applications. This approach addresses the identified need for personalized learning experiences while maintaining the structural integrity necessary for comprehensive skill development.

Future research should investigate the framework's longitudinal impacts, cross-cultural applicability, and scalability to determine its broader relevance in diverse learning contexts. Such studies will contribute to the advancement of robust, human-centered frameworks that effectively integrate technological innovation into digital entrepreneurship education.

Conclusion

This research validates the effectiveness of an integrated educational approach that integrates a responsive agentic AI online learning platform with WIL, digital tools, and targeted coaching methodologies to optimize digital personalized learning competencies among digital entrepreneurs. Curriculum architecture strategically balances theoretical foundations with establishment-based practical applications, allowing participants to develop a comprehensive understanding of digital consumer behaviors while simultaneously building applied skills in web applications, social media platforms, and graphic design for immediate business implementation.

The findings affirm that this multifaceted approach yields substantial business impact, with over 60% of participants reporting enhanced performance metrics, encompassing increased sales, expanded customer acquisition, and investment growth. By integrating foundational knowledge with practical digital competencies within a cohesive, business-relevant framework that accommodates individual learning needs and schedules, this model represents a significant advancement in entrepreneurial education—specifically tailored to equip entrepreneurs with the essential skills needed for success in an increasingly digitalized business landscape.

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