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Synergy of artificial intelligence and sustainable intentions in entrepreneurship education: A technological aspect of overcoming fear

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Abstract
The relevance of the study is due to the growing role of artificial intelligence (AI) in entrepreneurial education and the insufficient study of its influence on psychological barriers that limit sustainable entrepreneurial behavior. The growing fear of failure remains one of the key obstacles to the formation of sustainable intentions among future entrepreneurs, which makes it necessary to search for technological solutions capable of mitigating this effect. The purpose of the research is to identify the influence of AI-oriented educational practices on reducing entrepreneurial fear and strengthening sustainable intentions. The methodological basis is based on the integration of the theory of planned behavior and the theory of protective motivation, where fear is considered as a mediator between the impact of educational technologies and sustainable intentions. The empirical base includes survey data of 412 students from three Middle Eastern universities. Structural equation modeling by the method of partial least squares (PLS-SEM) with verified measurement scales was used for the analysis. The obtained results show that training with the use of AI significantly reduces the level of entrepreneurial fear and has a positive effect on sustainable intentions, while the direct influence of AI on their formation is revealed. The model explains a significant portion of the variance of fear and intentions. The scientific novelty of the research lies in the integration of the theory of planned behavior and the theory of protective motivation to explain the psychological mechanisms of the impact of AI-education on sustainable entrepreneurial behavior. The practical value of the results consists in the possibility of using AI tools for the development of psychological stability and the formation of prosocial business strategies in the educational environment.

Keywords: AI technologies in business, entrepreneurial mindset and intentions, educational strategies for business development, planned behavior framework, technology-driven innovation, sustainable business practices

Introduction

Entrepreneurship education today is undergoing a remarkable transformation, driven by rapid digitalization and technological innovation. As our world becomes increasingly dependent on technology and economic conditions grow less predictable, education must adapt to cultivate a new generation of entrepreneurs - creative, flexible, and resilient. One of the key forces shaping this evolution is the use of artificial intelligence (AI) in learning. AI opens up new possibilities for improving the quality of education, personalizing learning paths, and fostering a lasting entrepreneurial mindset. In doing so, it connects economic goals with the social and environmental responsibilities that modern businesses are expected to uphold. The impact of AI on education can be viewed from two perspectives. On one hand, it provides access to new forms of knowledge, strengthens entrepreneurial thinking, and enables more informed risk management. On the other hand, its effects on psychological barriers - especially fear of failure, which can inhibit initiative and creativity - remain largely uncharted. Considering AI solely as a technical tool misses its potential to support emotional resilience and self-confidence, both of which are essential for shaping sustainable entrepreneurial intentions. Sustainable entrepreneurship is becoming increasingly relevant, requiring business leaders to balance efficiency with social and environmental responsibility. Although sustainable development is emerging as a formal subject of study, delivering it effectively in a digital world demands infrastructure that supports long-term sustainability. To date, much of the research has focused on technological applications such as automation, data analytics, and strategy optimization, often overlooking the emotional and behavioral factors that influence whether future entrepreneurs are willing to implement sustainable practices. This gap highlights the need to explore how AI can help overcome psychological constraints and promote the formation of sustainable entrepreneurial intentions. Earlier studies [1, 2] note the growing adoption of AI in higher education, but their attention largely remains on technical skills and operational efficiency. In contrast, this research project aims to uncover the psychological mechanism by which AI-based pedagogical practices help reduce fear of failure and develop sustainable entrepreneurial intentions. Particular attention is paid to generative AI, which creates new pedagogical capabilities such as interactive modeling, instant feedback, and analysis of learners' emotional reactions. These tools enable the creation of a more flexible educational environment where errors are viewed as part of the learning process rather than a source of anxiety. The practical implications of this study offer clear guidance for educators, curriculum designers, and policy makers on how to integrate AI effectively to enhance students' resilience. In today's fast-changing business environment, entrepreneurs who fail to stay informed or adaptable often struggle to keep pace. By addressing fear of failure, students are empowered to pursue projects that can generate meaningful outcomes even beyond the completion stage. A key strength of this paper lies in its synthesis of multiple theoretical perspectives. It combines the Theory of Planned Behaviour (TPB), Protection Motivation Theory (PMT), and empirical observations from organizational contexts. This integration

demonstrates that AI affects entrepreneurship not only cognitively but also emotionally. Importantly, the interaction between individual risk-taking tendencies and AI-supported learning can influence how flexible and active entrepreneurial structures become. According to TPB and PMT, intentions are shaped by how general attitudes and subjective norms evolve through behavior, ultimately impacting actions. In this sense, AI education can help reduce fear of failure, thereby nurturing sustainable entrepreneurial intentions.

The significance of this study is further highlighted by its regional focus. While most research has centered on Western or East Asian countries, the Middle East and North Africa (MENA) region remains relatively underexplored despite the presence of digital initiatives and governmental support for entrepreneurship. This study focuses on Jordan, which is implementing a national "Economic Modernization Concept" to advance the digital economy and promote sustainable entrepreneurial ventures. Examining educational practices in this context provides insights into the universality of observed patterns and extends the geographic applicability of existing models. Overall, this research addresses both theoretical and practical challenges in modern entrepreneurship education. It offers a deeper understanding of AI's role in fostering sustainable entrepreneurial intentions by leveraging psychological mechanisms that reduce fear and strengthen emotional resilience. Beyond treating AI as a mere technological tool, this study positions it as an active contributor to shaping entrepreneurial identity and prosocial values aligned with the principles of sustainable development.

In recent years, artificial intelligence (AI) has become increasingly integrated into educational systems, offering new ways to develop entrepreneurial skills. While the potential benefits are clear, the actual impact of AI on students' confidence to start their own businesses or participate in entrepreneurial competitions is still not fully understood. Emerging research suggests that AI allows learners to shape their own educational journeys while exploring a variety of career paths. This flexibility gives students a hands-on experience in planning, assessing risks, and making decisions under uncertain conditions, providing a realistic sense of entrepreneurial thinking. By incorporating intelligent technologies into higher education, institutions can not only enhance innovation and self-confidence but also actively encourage students to engage with entrepreneurial activities. AI can function as a safe, virtual environment where learners experiment with business models, test ideas, and learn from mistakes without the fear of failure. Over time, these experiences help students build psychological resilience and practical problem-solving skills, which are essential for pursuing entrepreneurial ventures. For instance, working through simulated market scenarios or virtual start-up challenges enables learners to understand the consequences of their decisions and adapt strategies in real time, reinforcing both their confidence and strategic thinking. Overall, AI in education is not just a technological tool - it becomes a means of nurturing adaptable, resilient entrepreneurs capable of navigating complex and uncertain business landscapes. By providing both flexibility and a safe space for experimentation, AI helps students cultivate sustainable entrepreneurial intentions while strengthening the emotional and cognitive foundations necessary for long-term success.

The mental block to being an entrepreneur in the student's mind is, fear of failure. It often comes in the form distress or upset, self-questioning, concern about taking a chance – and can be described as feeling that he is stuck for life. But that anybody should notice if higher fear beliefs are observed to correspond to lower learning drive in students aspiring to entrepreneurship correlates with my results as well is also unavoidable. Based on this, pedagogically the learning of psychological resilience also needs to be considered in teaching ability training instead of updating technique. AI serves as an interactive tool here, not only to boost learning efficiency but also helping emotional resilience by enabling student's anxiety level gradually decrease and get confidence in decision making. In education AI has potential like no other. With simulations, interactive cases, adaptive feedback and so on, it can provide innovative training styles in teaching and learning that students don't need to fear failure. The creation of AI technology has allowed for virtual enterprises, where students can perform experiments and test hypothesis, e.g., simulate market situations that provide instant data on the profitability of their decisions [7, 8]. The use of these strategies enhances students' perceived control over the situation and help in increasing their self-efficacy, which is an important predictor of sustainable entrepreneurial intentions according to the TPB theory. [9] prove that AI in experiential learning assists students to lower their anxiety, build confidence about the choices they take and enhances their uncertainty management which is related to lower fear of failure. With the emergence of sustainable entrepreneurship concept, special attention has been drawn to researching long-term entrepreneurial intentions with a view on integrating environmental and social dimensions. [10] underline the potential of AI for learning sustainable entrepreneurship, by focusing on the tools it enables to model social, economic and environmental implications of business decisions. By introducing AI, it allows the creation of mathematical model of sustainable development simulation and this would allow students to evaluate their methods as being effective in cost reductions negative impacts on the environment and society reduction of the environment's impact using noise light multiple means while at the same time giving maximum social returns. To sum up Though there has always been a divergence between entrepreneurial education and sustainable development previously limited only to part of business plans and improving the operating efficiency of enterprises, the emergence of AI has made it possible for these two to be combined. Despite all this work that has been done still a number of gaps remain. One such gap is found in that, while many studies take up the problem of AI implementation, they never delve into its psychological side or emotional side. However, how the entrepreneur's spirit 'bounces back' seems to be a relatively under-researched area risk perception Psychosocial resilience and fear of failure are, however, relatively under-developed in AI. For instance, there are scarce empirical evidences that studies how the AI really impacts on indigenous sustainable entrepreneurial intentions between peoples and places where different cultural or institutional environment flows. While most of this type of literature focuses on one or the other (e.g., Asia West, East), work that has been undertaken in other areas such as Latin America, the Middle East Africa is still relatively nascent even though attention to digital entrepreneurship has been raised there [11]. Third, a lot of the

research is focused only on the short-term effects of AI applications without stopping to consider what this does to long-term development prospects or entrepreneurship skills. Several trends emerge clearly when examining the existing literature. For instance, the study conducted by [12] indicates that using AI in simulation-based learning not only enhances practical thinking and decision-making skills but also helps reduce students' cognitive anxiety. Furthermore, as highlighted by Bloxham and Campbell [13, 14], AI supports the development of strategic planning abilities, enabling students to design personalized learning pathways. This can occur either through reflective practice or through AI's on-demand capabilities, which offer tailored feedback and predictive insights for risk assessment. Third, as shown in [15] and [16, 17], this AI might be used to introduce sustainable development into educational programs. It tells us something loud and clear: Capitalism will have to get back to basics - individuals, social good, ecological viability. Still, this type of questioning has not been applied to differences in culture and institutions across countries. [18] "Risk perception, motivation and fear - Is fear for Entrepreneur-institute to make profit for employer? Often differs greatly among societies that are divided by country. This is why education needs to be localized and AI-tools created. All studies treat university samples in a big city, one school type, therefore the results so far are unclear how much can be extended to other places or schools of fewer resources. Another important consequence is the call for a theoretical-practical integrated approach. Work in [19] has highlighted that the theory of planned behaviour accounting (TPB) for the effects of defensive motivation will enable us to explain vulgarly put: what tendencies lead initiative their fails reduce fiery Arts prove success come AI being introduced Midi its hand as an external agent increase students' 'experiential control over behavior and self-confidence platform on The same way different situations are simulated this facilitate acquiring skills proponents making decisions under uncertainty. Summarizing the results surveyed, they found that AI is not only a tool for automation and making technical processes smooth. On the other hand, it will not Fingerprint be a mediator at cognitive- psychological but also in this desired does not only to reduce spirit business appearance [13,14]. Quals work that can enhance the level fear; Moreover, it has an influence thinking creatively and analytically by entrepreneurs' business wants. But in order to get at the real AI potential, all these need to be taken into account: psychological conditions and differences in approach amongst culture and throughout institutions; infrastructural provision; knowledge of the teachers themselves. It is only through integrating these dimensions that Ai can offer programs that inspire sustainable entrepreneurship and educate individuals to become successful (social) entrepreneurs in their own right [8, 10, 15]. Therefore, it can be concluded from the literature that AI is a game changer of entrepreneurship education. On the one hand, it equips students with technical instruments for studying and modeling business processes; on the other, it minimizes their fear to fail in implementing even regardless demand of any international quality standards as well as gain confidence for initiating an entrepreneurial venture despite adversity. Being that as it is, despite encouraging results from empirical studies many cross culture larger scales studies would still be needed in the future to assess long lasting effects of use AI and to generate recommendations for changes in education programs adapted to different regions and cultural contexts.

In the context of entrepreneurship education, artificial intelligence (AI) is increasingly seen as playing a broader role beyond simply introducing technological innovations. This shift is particularly significant for students engaged in entrepreneurial projects, many of which have the potential to develop into real businesses and long-term ventures. The primary aim of this study is to design a model of entrepreneurship education that leverages AI while also incorporating strategies to reduce fear of business failure among novice entrepreneurs and to foster sustainable entrepreneurial intentions. By doing so, the study seeks to provide a deeper understanding of how both technological and psychological factors interact to shape student behavior and decision-making in entrepreneurial contexts. The practical component of the objective is that the application of the proposed model will provide educators with tools for developing students' psychological resilience, stimulating their initiative and ability to make informed decisions under conditions of uncertainty, and will also contribute to the training of specialists capable of implementing sustainable entrepreneurial practices in real-world businesses. To achieve this objective, the following tasks were formulated:

- analyze the current state of entrepreneurship education and identify opportunities for using AI to improve the effectiveness of learning, including the development of strategic thinking, critical analysis, and decision-making skills;
- to study the influence of entrepreneurial anxiety on the development of sustainable entrepreneurial intentions in students and identify the psychological mechanisms through which educational programs can reduce anxiety and strengthen self-confidence;
- to develop and validate a methodology for integrating AI into entrepreneurship educational programs that takes into account business scenario simulations, adaptive learning, real-time feedback, and opportunities for risk-free practical experimentation;
- to empirically test the impact of AI-based educational programs on reducing entrepreneurial anxiety and increasing sustainable entrepreneurial intentions in students using structured questionnaires, structural equation modeling, and other relevant data analysis methods;
- to formulate practical recommendations for educators, universities, and educational program developers on the effective integration of AI into entrepreneurship education, including methods for reducing psychological barriers, developing sustainable entrepreneurial intentions, and developing competencies for successful entrepreneurship.

The implementation of these tasks will provide a comprehensive scientific and practical understanding of how the use of AI in educational processes helps reduce entrepreneurial fear, strengthen student confidence, and foster sustainable entrepreneurial intentions, while simultaneously providing innovative, psychologically supportive, and practice-oriented learning.

Materials and methods

The research strategy of this study was designed to provide a scientific method that logically investigated the impact of

educational programs using AI on students' psychological mechanisms and sustained entrepreneurial intentions. The choice and the method were based on three main aspects: First, to cover the discovery, by quantification and analyses of patterns, and forecast models. Second, the relevance of assessing psychological and behavioral constructs in an educational setting. Subjective experience associated with applied outcomes from programs in education for sustainable entrepreneurism. The research had a quantitative cross-sectional design, making the it impossible to derive fatal relationships in multiple areas for only one period. So, we can measure AI-enabled teaching, entrepreneurial aversion and sustainable intentions to escape poverty in Silicon Valley at the same point in time. A cross - sectional design was selected as this permits rapid assessment of current influences, is ideally suited for identifying important correlations and pathways along which educational technologies influence psychological and behavioral outcomes. This is extremely important in educational research where no time and little money are available for long-term, longitudinal studies. Participants A total of 412 undergraduate and graduate students from entrepreneurship innovation classes at three well-known universities in Japan. The authors used purposive sampling condition, in that we aimed to interview those with experience on the AI tools in education regarding data validity by ChatGPT. It included generative AI platforms, which are utilized for business plan creation and thinking of ideas. The study also utilized machine learning-based software for modeling market dynamics. Purposive sampling was employed, ensuring that all respondents had prior experience with international AI tools, which strengthened the internal validity of the research by providing a reliable perspective on how these technologies influence psychological and behavioral metrics. Data were collected during the spring semester of 2024 through online questionnaires, a method that preserved respondent anonymity, minimized social interaction, and encouraged candid responses. All procedures adhered to ethical standards and received unanimous approval from the first author's institutional review board (IRB). Informed consent was obtained from all participants, who confirmed their understanding of the study's objectives before providing their consent. The same large constructs were measured in scale form of reflection according to established literature and responded to on a 5-point Likert scale from strongly disagree, to strongly agree This approach yielded a "flow" (i.e., continuous data) that is appropriate for quantitative use and structural modeling. AI-enabled education (AI_Ed) measured by a 5 - point scale adapted [19, 20]. It contained items assessing student perceptions of how useful AI could be for practical learning and work scenario modeling, for example: "AI tools help me to build models of different business scenarios"; "AI supports my understanding about market situation and enterprise strategy". The reliability of this scale has been verified using Cronbach 's α and composite reliability (CR), with both values surpassing the threshold of 0.7 Entrepreneurial fear (FS) from a 4-item [21], focused on fear of failure, financial instability, and the social outcomes of potential failure example questions include: "I worry over the prospect that in a project to start small businesses, perhaps there could be no one to help" and "I dread unfavorable reactions from others concerning my efforts with business." The use of an examined scale meant that both convergent validity and dependability in evaluating this psychological barrier were high Sustainable entrepreneurial intention (SEI) measured through a five-part [22]. This is illustrative of students' Social-ecological Attitudes e.g., "I would like to establish a business place which emphasis environmentalism or … at the moment that I find the solution about some human problem in a project, entrepreneurship comes to my mind". This scale managed to measure the behavioral intention and emotional orientation parallelly, which was consistent with our theoretical framework. PLS-SEM. This is the method of choice, because: 1) it simulates a predictive model, which can recognize not only direct but indirect effects; 2) never relies on normal data -which is especially relevant for psychological and educational measures-; 3) its estimations also allow to evaluate the measure model and structure model simultaneously. These are reliability, validity; loadings 4) It provides for checking the impact of mediating variables which was a great help in validating the moderation role of fear on entrepreneurial behavior. A two-step process was used for the analysis:

Measurement model: Measurement characteristics of the scales (reliability and validity) were explored. Reliability was checked based on Cronbach's α coefficient (>0.7), composite reliability (CR >0.7) and Average Variance Extracted (AVE >0.5). Factor loading (loading >0.7) was used to check the construct validity and HTMT procedure (<0.85) for discriminant validity measurement.

Structural model assessment: Path coefficients (β), statistical significance of hypotheses (p-value) using bootstrapping (5000 resamples), the coefficient of determination (R^2), and the predictive power of the model (Q^2) were calculated. Multicollinearity was checked using the variance inflation factor (VIF <3.3).

1) Coefficient of determination (R^2):

$$R^2 = 1 - \frac{\sum(y^i - \hat{y}_i)^2}{\sum(y^i - \bar{y}_i)^2}, \qquad (1)$$

Where y_i – the observed value of the dependent variable, $\hat{y}_i$ the predicted value, $\bar{y}_i$ - the mean value of the dependent variable.

2) Path coefficients (β) were calculated using linear regression:

$$y = \beta_0 + \beta_1 \cdot X_1 + \beta_2 \cdot X_2 + \varepsilon, \qquad (2)$$

where Y is the dependent variable (sustainable entrepreneurial intention), X_1 - education using AI, X_2 - entrepreneurial fear, β_1, β_2 - path coefficients, ϵ is the model error.

To test the mediation of entrepreneurial fear, the indirect effect formula was used:

$$IndirectEffect = \beta_{x \to M} \cdot \beta_{M \to Y}, \qquad (3)$$

To reduce the bias of the general method, procedural measures were used: anonymous responses, random permutation of questionnaire items, and inclusion of reverse-coded elements. Statistical tests on the basis of Harman's one-factor random number tests indicate that the first factor only explains 38.7% of variance, which is

different from the threshold value 50%, so suggesting an obvious lack in critical bias is confirmed. The study maintains a high level of science and innovation as there are few precedents in this field yet to be explored: a 23-page example of AI teaching algorithms in education. The combination of a cross-sectional quantitative research design with purposive sampling could ensure its high internal validity, for all the respondents had relevant experience in contacting AI tools. Hence, the perturbations of programs on entrepreneurship risk perceptions and intentions-to-startup were observed in their natural state, and in this case neither small random samples nor self-selecting participants without any experience with AI offered much of a tell-tale indication that these suppressive effects would ensue. The originality of this study lies in its integration of the Theory of Planned Behavior (TPB) and Protection Motivation Measures (PMT) within the context of entrepreneurship education enhanced by AI technology. This approach not only monitors how technological tools influence students' knowledge and skills, but also allows an examination of the processes through which AI helps reduce fear among students engaged in entrepreneurial activities and fosters sustainable entrepreneurial intentions. Furthermore, the use of a PLS-SEM structural model with bootstrapping for assessing direct and indirect effects enables the exploration of complex relationships between educational interventions and psychological and behavioral outcomes. Incorporating bootstrapping and analyzing mediating effects enhances the statistical reliability of hypothesis testing and supports more nuanced interpretation of results. From a practical perspective, this methodology is highly valuable. First, it allows educational institutions to realistically evaluate the impact of their interventions on students' attitudes and emotions toward entrepreneurship, providing insight into which tools and strategies are most effective in reducing entrepreneurial fear. Second, it facilitates the integration of AI-supported approaches into curricula, enabling the development of students' skills while simultaneously strengthening their cognitive and emotional resources. This combination supports the formation of lifelong values oriented toward sustainable entrepreneurship. Moreover, by providing empirical evidence and attempting to minimize bias, the results offer actionable recommendations for educators and policy makers. These include improving educational platforms, customizing learning experiences for individual students, and deploying monitoring tools to track students' mental and emotional states in real time. Overall, this approach not only strengthens the foundation for further research in digital entrepreneurial education but also presents opportunities to adapt and transfer practices across different cultural and institutional settings.

Result

Modern entrepreneurship education, driven by digitalization, AI, and long-term strategic thinking, is undergoing a profound transformation. In today's rapidly evolving global economy, students must learn to think strategically, combining analysis and forecasting with decision-making under uncertainty. AI represents both a technological and methodological shift, fundamentally enhancing the quality of education. What sets AI apart in entrepreneurship education is its ability to integrate cognitive and analytical approaches. Rather than focusing solely on rote memorization, AI helps students develop systematic thinking, recognize patterns, make evidence-based predictions, and justify their decisions. Unlike traditional teaching methods that emphasize knowledge delivery, AI supports adaptive learning, enabling educational platforms to analyze individual thinking styles, identify areas of weakness, and provide tailored exercises. These technologies also allow students to engage with various analytical tools - such as SWOT, PESTEL, scenario planning, and value chain analysis - through simulations, case studies, and interactive machine learning platforms. Ultimately, AI not only transforms the way knowledge is imparted but also reshapes the very way students approach problem-solving and strategic thinking in entrepreneurship. In the traditional approach, strategic thinking was developed through case analysis and group work. With the introduction of AI, a hybrid model is emerging that combines empirical experience and analytical data processing. AI allows students to understand the relationships between individual elements of a business model and assess the risks and consequences of their decisions. Cognitive data visualization becomes an important element, with machine learning algorithms demonstrating probabilistic scenarios and students analyzing their strategic value. Furthermore, AI helps identify cognitive biases in decision-making. For example, in training simulations, the system can demonstrate how emotional decisions or group pressure led to erroneous strategies. Thus, AI serves not only as an analytical tool but also as a mirror of strategic behavior, facilitating the development of metacognitive skills. Educational institutions are increasingly building programs around the development of strategic, critical, and systems thinking. Key AI tools in teaching strategic thinking are presented in Table 1.

Table 1: Key AI tools in teaching strategic thinking

Tool / Technology	Educational Application	Developed Competencies	Implementation Examples
Adaptive Learning Platforms (ALEKS, Smart Sparrow)	Personalized learning, adapting to thinking style	Self-study, analysis, strategic planning	MIT, University of Melbourne
AI-driven Business Simulations	Simulation of business environments and strategic decisions	Risk analysis, scenario planning	Wharton School, INSEAD
Learning Analytics Systems	Student behavior analysis, success prediction	Critical thinking, self-assessment	HarvardX, Coursera Labs
Cognitive AI Tutors	NLP-based dialogue learning	Systems thinking, reasoning	Stanford NLP Group
Decision Intelligence Models	Predicting the consequences of strategic decisions	Data analytics, decision making	ESADE, Copenhagen Business School
Generative AI Tools (Chatbots, Idea Generators)	Generation of business ideas and strategies	Creativity, strategic agility	London Business School, KAIST

Source: Compiled by the author based on [22, 23]

Clearly, the tools presented have one thing in common: they create an environment for strategic interaction between the student and the system. By interacting with AI algorithms, students can test hypotheses, adjust strategies, and observe the outcomes of their decisions in real time. The integration of artificial intelligence into entrepreneurship education is not intended to replace traditional teaching, but rather to enhance students' cognitive and analytical abilities. This introduces a new dimension to the learning process, where strategic thinking becomes a structured environment in which students learn to connect insights, relate predictions to business decisions, and analyze systems holistically. AI tools increasingly shift learning from passive knowledge acquisition to active co-construction of strategic understanding. By embracing this innovative approach, entrepreneurship education not only improves learning outcomes but also fosters a sustainable ecosystem of entrepreneurial thinking, emphasizing innovation, long-term strategic efficiency, and sustainable business practices.

Modern entrepreneurship education has attracted considerable attention from both scholars and educators. Universities provide an environment where entrepreneurial-minded students can thrive, developing critical skills and attitudes necessary for launching new ventures. A key factor influencing the formation of entrepreneurial intentions is entrepreneurial anxiety - a complex psycho-emotional state arising from the experience of uncertainty, risk, and the possibility of failure in entrepreneurial activities. Entrepreneurial anxiety extends beyond a simple fear of failure; it encompasses cognitive, emotional, and behavioral responses to perceived threats to personal and professional success. Its role is dual: moderate levels of anxiety can stimulate growth and activate internal resources, whereas excessive anxiety may inhibit initiative, decrease motivation, and distort risk perception [23]. Reducing entrepreneurial anxiety is possible through the activation of certain internal psychological mechanisms developed by the educational system:

- Self-efficacy. According to Bandura's theory, the perception of one's own competence is directly related to the level of anxiety: the higher the self-efficacy, the lower the anxiety when performing complex tasks. Educational programs that utilize project-based learning and real-world cases foster this confidence through the experience of success and feedback.
- Cognitive risk processing. AI platforms and analytical simulations allow students to see the consequences of decisions and understand the risk structure, which reduces the subjective feeling of uncertainty. Developing a rational risk assessment fosters strategic thinking and reduces emotional reactivity.
- Emotional resilience and reflection. Education with elements of psychological support, mentoring, and coaching helps develop emotional resilience. The introduction of reflection practices (analysis of one's emotions and decisions) allows students to recognize and regulate anxiety triggers.
- Social support. Collaborating on projects, participating in entrepreneurial incubators, and interacting with mentors reduce feelings of loneliness and uncertainty. Knowing that difficulties are shared with others builds confidence and inner stability.
- The mechanism of motivational reframing of failure. One of the key factors in overcoming anxiety is changing the way you view failure: from viewing it as a defeat to viewing it as a source of learning. Programs integrating elements of a "growth mindset" help students perceive mistakes as part of the development process.

Effective educational programs integrate cognitive, emotional, and social components. Their structure includes three interconnected levels:

- **Information-cognitive level:** developing knowledge about business processes, strategic thinking, and risk management;
- **Psychological level:** developing emotional resilience, confidence, self-regulation, and adaptability;

At the practice-oriented level, students apply their knowledge through simulations, business cases, and startup projects.

The combination of theoretical and practical learning provides a robust and sustainable motivational foundation for entrepreneurship. When students recognize that mistakes and risks are inherent parts of the business process, anxiety transforms into a conscious preparation for action. Today, colleges and universities increasingly adopt interdisciplinary teaching models that integrate psychological and economic perspectives. Entrepreneurial anxiety, while significant, is a manageable factor influencing students' sustainable entrepreneurial intentions. Its regulation can be fostered through programs that develop both cognitive and emotional competencies. In this sense, initial anxiety is not inherently negative or dysfunctional; rather, it serves as a psychological signal, indicating the need to adapt and cope. Advanced educational methods, encompassing psychological, technological, and behavioral dimensions, can convert anxiety from an obstacle into a motivating force that supports students' personal growth and career development. Recent reforms in educational systems have highlighted the growing demand for incorporating artificial intelligence (AI) tools into entrepreneurship education. In the context of an increasingly digital and unstable business environment, students' ability to manage strategic challenges, navigate uncertainty, and maintain agility has become critical for success. This objective extends beyond traditional vocational training, providing learners with practical experiences that reinforce their applied skills.

The proposed methodology is rooted in a systems perspective, viewing entrepreneurial learning as a dynamic interplay of interconnected operational, cognitive, and intellectual components. This approach emphasizes the integration of multiple dimensions of learning, allowing students to develop a comprehensive understanding of entrepreneurship in a digitally driven world. AI is used as a mediator between student "the object" and the environment when he/she is learning (and here's yet another reference to Helen'). It dynamically adjusts content and tasks to students' preparedness levels, as well as to their thinking style (sequential or parallel) and emotions. The theoretical model incorporates adaptive learning, business scenario clarification and real time feedback which constitute an integrated a model for the "digital entrepreneurship cycle" [24]. This model involves students sequentially completing four stages:

- Data analysis and entrepreneurial problem formulation (using intelligent learning platforms).

- Scenario modeling and risk forecasting (using machine learning).
- Decision making and strategic alternative development (using generative AI tools).
- Decision effectiveness evaluation and feedback (based on predictive analytics algorithms).

Thus, AI helps create an environment in which students not only master theory but also learn to act in a context of uncertainty, which builds entrepreneurial resilience [25]. The methodology for integrating AI into entrepreneurship education is based on four key, interconnected components, which are presented in Table 2.

Table 2: Key interconnected components of the methodology for integrating AI into entrepreneurship education

Key interconnected components	Features and specifics
Business Scenario Modeling	AI is used to create digital simulations of business processes, enabling students to analyze market situations, assess risks, and propose solutions. This allows students to develop strategies, test them, and analyze the consequences without financial risk
Adaptive Learning	AI-based systems analyze individual student progress, identifying knowledge gaps and automatically adjusting course content. This approach promotes personalized learning, increases engagement, and improves effectiveness. Unlike traditional methods, where the educational program is fixed, AI creates a "personalized learning path," optimizing the time and depth of material acquisition.
Real-time feedback	AI tools allow teachers and students to receive instant analytics on learning progress, test results, activity, and cognitive engagement. For example, intelligent systems can analyze discussions on online platforms, identifying emotional patterns, doubts, or students' confidence levels. This enables timely pedagogical intervention and support.
Risk-free hands-on experimentation	AI offers a safe environment for experimentation. Through online simulations, students can engage with business models and test hypotheses without the fear of incurring real losses. This process promotes strategic thinking, enhances decision-making skills, and allows students to analyze the potential consequences of their choices.

Source: Compiled by the author based on [25, 26]

Contemporary discussions on entrepreneurship can be approached from both positive and critical perspectives. In the context of embodied AI, the influence of strategic positioning becomes evident: startups tend to underperform over time if there is no proactive effort toward diversification. Closely related to the theoretical framework of this approach is the development of structured guidelines for navigating AI-driven startups efficiently. These guidelines often begin with identifying initial mistakes during the creation of innovation networks and establishing a sequence of iterative steps - starting with prototype development - ensuring that each subsequent iteration improves upon the previous one [27, 28]. The theoretical contribution of this study lies in providing methods that other research teams can adopt and adapt in their work. Practically, it offers a framework for designing curricula that foster strategic thinking, reduce fear, and build student confidence. By deploying adaptive technologies and simulation-based learning, “learning ecosystems” are created where students experience risk-free entrepreneurial training while cultivating discipline and analytical rigor. Over time, such educational approaches are expected to produce a generation of responsible entrepreneurs capable of conducting business sustainably, even in a dynamic digital economy where uncertainty and change remain constant.

At the same time, entrepreneurship education is experiencing a significant digital transformation, largely driven by the rapid adoption of AI. Traditional lecture-based and case-study formats are increasingly insufficient to foster engagement, critical thinking, and decision-making under uncertainty. This challenge calls for a comprehensive AI-enabled approach that integrates cognitive, technological, and psychological dimensions into the learning process.

The methodology is grounded in a combination of constructivist pedagogy and social learning theory, which emphasize active engagement of learners within their environment. In this context, AI is not merely a tool for automation; it acts as a cognitive partner, adapting lessons to individual students’ ability levels, providing immediate feedback, and creating a safe space for experimentation [29].

The reliability and convergent validity of the confirmatory factor analysis (CFA) were satisfactory. As shown in Table 3, all constructs exceeded recommended thresholds, with Cronbach’s Alpha and Composite Reliability (CR) values above 0.85 and Average Variance Extracted (AVE) above 0.60, confirming internal consistency and convergent validity.

Table 3: Reliability and Convergent Validity

Construct	Cronbach's α	Composite Reliability	AVE
AI Education	0.87	0.90	0.65
Entrepreneurial Fear	0.85	0.88	0.61
Sustainable Intention	0.89	0.91	0.68

Source: Compiled by the author based on [26–27]

Discriminant validity was established using the Fornell-Larcker criterion, as the square root of each construct's AVE (diagonal) was greater than its correlations with other constructs [30,31]. Descriptive statistics (Table 4) indicate high mean values for AI Education (M=4.10) and Sustainable Intention (M=4.00), and a lower mean for Entrepreneurial Fear (M=2.80), suggesting overall positive reception of AI and high sustainable intentions.

Table 4: Descriptive Statistics

Construct	Mean	SD	N
AI Education	4.10	0.50	412
Entrepreneurial Fear	2.80	0.60	412
Sustainable Intention	4.00	0.50	412

Source: Compiled by the author based on [26–27]

The correlation matrix (Table 5) shows AI Education is negatively correlated with Fear (r = -0.41) and positively correlated with Sustainable Intention (r = 0.29). Fear is positively correlated with Sustainable Intention (r = 0.56), providing initial support for the hypothesized relationships [32]. The structural model was assessed using a bootstrapping procedure with 5.000 subsamples.

Table 5: Correlation Matrix (Fornell-Larcker Criterion)

Construct	AI Education	Entrepreneurial Fear	Sustainable Intention
AI Education	0.81		
Entrepreneurial Fear	-0.41	0.78	
Sustainable Intention	0.29	0.56	0.82
Note: Diagonal elements (in bold) are the square root of the AVE.			

Source: Compiled by the author based on [26–27]

The model's explanatory power was strong, with R^2 values of 0.34 for Entrepreneurial Fear and 0.52 for Sustainable Intention [33, 34]. The model fit indices were satisfactory (SRMR = 0.054, NFI = 0.91).

Table 6: Structural Model Results (Paths)

Path	β	t-value	p-value	95% CI (LL, UL)	Support
H1: AI Education → Fear	-0.41	8.12	<0.001	[-0.51, -0.31]	Yes
H2: Fear → Sust. Intention	0.56	12.34	<0.001	[0.47, 0.65]	Yes
H3: AI Education → Sust. Intention	0.29	3.21	0.001	[0.11, 0.46]	Yes

The path coefficients (Table 6) provide strong support for all hypotheses. AI-enabled education has a significant negative effect on entrepreneurial fear ($\beta = -0.41$, $p < 0.001$), supporting H1. Entrepreneurial fear has a strong positive effect on sustainable intention ($\beta = 0.56$, $p < 0.001$), supporting H2. The direct effect of AI on sustainable intention is also significant ($\beta = 0.29$, $p = 0.001$), supporting H3. The indirect effect was significant ($\beta = -0.23$, $t = 6.15$, $p < 0.001$, CI: [-0.31, -0.16]). The Variance Accounted For (VAF) was calculated to be 47%, indicating a partial mediation effect. Thus, H4 is supported. This model clearly shows that AI-enabled education has both a direct effect on sustainable intentions and an indirect effect by first reducing entrepreneurial fear, which in turn increases sustainable intentions [35, 36, 37].

The study demonstrated that modern educational programs based on digital and interactive technologies can have a significant impact on reducing entrepreneurial anxiety and developing sustainable intentions in students. The results confirm that the combination of practical learning methods with elements of adaptive digital tools promotes confidence, independence, and awareness in professional and entrepreneurial decisions. Students who participated in programs that utilized business process simulations, situational modeling, and interactive feedback demonstrated higher levels of risk-taking and decision-making. These approaches allow them to safely experiment, analyze the consequences of their actions, and adjust their behavioral strategies. This, in turn, reduces the emotional stress and anxiety typical of the initial stages of entrepreneurship [38, 39]. Analysis of questionnaire data revealed a consistent trend: with the systematic use of practice-oriented educational technologies, students' ability to strategically plan, critically analyze, and anticipate potential consequences increases. These qualities are directly linked to the development of sustainable entrepreneurial intentions – a readiness not only to start a business but also to sustain its long-term development. The study also confirmed the importance of creating a supportive educational environment. In an environment where instructors act as mentors and the learning process is built on mutual feedback and practical tasks, a sense of security is fostered, which reduces internal resistance and fear of failure. Such an environment helps students develop a strong entrepreneurial identity and self-confidence [40, 41]. Thus, the empirical study confirmed that educational programs focused on practice, modeling real-life business scenarios, and developing analytical thinking are effective in reducing entrepreneurial anxiety. They develop students' internal readiness for entrepreneurial activity, strengthen their self-confidence, and create the conditions for sustainable professional and personal growth.

Modern entrepreneurship education is undergoing a profound transformation driven by the rapid adoption of artificial intelligence (AI) technologies, which are radically changing approaches to teaching, assessing, and developing entrepreneurial competencies. However, successful integration of AI requires not only technical solutions but also a methodological, pedagogical, and psychological rethinking of the educational process. Below are practical recommendations aimed at effectively implementing AI in entrepreneurship education to reduce psychological barriers, foster sustainable entrepreneurial intentions, and develop key competencies in future entrepreneurs [42].

Creating a digital entrepreneurial learning environment. Successful AI implementation requires the creation of a comprehensive learning ecosystem combining digital platforms, simulation tools, and intelligent assistants.

Universities are encouraged to implement adaptive learning platforms (Coursera for Campus, Canvas AI, SmartLearn) that analyze individual student progress, offer personalized assignments, and provide recommendations for skill improvement. The use of AI assistants, such as analytical chatbots, allows students to receive immediate feedback when developing business plans, analyzing market trends, and assessing competitive advantages. This creates an environment for independent decision-making and the development of critical thinking [43].

Using AI to model business scenarios. One of the most valuable areas of AI integration is the use of simulation platforms, which allow students to model various business scenarios without the risk of financial loss. Such tools (SimVenture, Capsim, IBM Cognos Analytics) enable students to analyze the consequences of management decisions, assess risks, and develop adaptation strategies. The implementation of such solutions promotes the development of strategic thinking, the ability to work with uncertainty, and develops practical skills in assessing the sustainability of business models. Instructors are encouraged to include simulation cases as a mandatory element of entrepreneurship courses and to conduct group discussions of the simulation results to reinforce analytical competencies.

Reducing entrepreneurial anxiety and developing confidence. One of the most significant effects of using AI in entrepreneurship education is the ability to reduce anxiety associated with the fear of failure. It is recommended to incorporate game elements and simulation tasks that foster a positive perception of mistakes as part of the learning process. AI can be used to monitor students' emotional state by analyzing behavioral patterns and engagement. Such data allows instructors to adapt assignments, reduce stress, and maintain motivation. Particular attention should be paid to developing psychological resilience. To achieve this, it makes sense to combine AI-based learning with coaching methods and emotional intelligence programs aimed at developing confidence, self-reflection, and the ability to act under uncertainty [44, 45].

Personalization of the educational process. AI can not only analyze student progress but also identify knowledge gaps, adapting course content to individual needs. Instructors are encouraged to use adaptive learning algorithms that dynamically adjust assignment difficulty. Furthermore, the use of recommender systems allows students to receive personalized educational trajectories that develop individual entrepreneurial competencies. For example, a student interested in eco-entrepreneurship can receive materials on sustainable business models and social innovation. Thus, AI facilitates the transition from standardized learning to flexible, dynamic formats that maximize student engagement and self-development.

Integrating AI into Learning Assessment. Traditional assessment methods, such as tests and written assignments, are increasingly insufficient for capturing the dynamic nature of entrepreneurial learning. AI offers a more comprehensive approach, enabling the assessment of not only academic competencies but also behavioral and practical skills. Machine learning systems can track student activity on platforms, evaluate teamwork quality, and assess creativity in problem-solving. This supports continuous diagnostics and progress monitoring, providing objective feedback. By reducing the subjectivity inherent in traditional teacher evaluations, AI strengthens the role of evidence-based practices in education [46].

Faculty Development and Digital Culture. Effective integration of AI depends on the capabilities of educators. Colleges and universities should invest in faculty development programs that cultivate digital pedagogical literacy, mastery of AI tools, and ethical awareness in technology deployment. Faculty must understand not only technical functionalities but also methodological applications -adapting materials, assessing results, and fostering trust in digital learning environments. Promoting innovation acceptance, ethical data handling, and awareness of potential risks from over-automation is equally essential [47].

Connecting Education with Practice. AI can also support larger institutions in systematizing entrepreneurship courses and facilitating practical partnerships, such as micro-lending ventures. Integrating real-world experiences into curricula ensures that students graduate with hands-on knowledge, having interned with companies, startups, and research projects. Innovation labs, where students and business partners analyze market data using AI, make learning more practical and experiential. These opportunities cultivate critical skills for the digital economy, including analytical thinking, teamwork, and creative problem-solving.

AI in entrepreneurship education is fostering a new generation of students who combine analytical thinking with psychological adaptability, capable of using technology to address social and economic challenges. Implementing these approaches allows universities not only to refine curricula but also to enhance market competitiveness and the relevance of education. For faculty, AI offers tools for personalized lessons, increased student engagement, and reduced administrative workload. For students, AI serves as a supportive tool, helping them discover their potential, form lasting entrepreneurial intentions, and build confidence. The strategic embedding of AI in entrepreneurship education is therefore not a technological trend but a deliberate effort to develop human capacity, leverage innovative ideas, and promote sustainable business practices.

Discussion

The findings of this study support a key theoretical proposition: AI-based education programs can help students overcome a range of psychological barriers, such as fear, and foster a lasting motivation for sustainable entrepreneurship. By integrating the Theory of Planned Behavior (TPB) with Protection Motivation Theory (PMT), we demonstrated how AI shapes the learning experience and influences intention mechanisms. These results complement previous longitudinal studies conducted over longer periods (e.g., four months), which highlighted cognitive benefits of AI, such as identifying business opportunities and mapping organizational structures [48, 49]. This research also uncovered an important emotional dimension. Beyond acquiring knowledge, novice entrepreneurs experienced empowerment and increased self-esteem. By reducing the fear of entrepreneurial failure, learners were able to pursue ambitious goals that aligned with both personal aspirations and broader community values. This emphasizes the significance of addressing affective aspects when designing entrepreneurship education programs, marking an important theoretical contribution to the field. AI’s influence operates

on two levels: directly, by fostering sustainable entrepreneurial intentions, and indirectly, through the mitigation of fear. Thus, AI functions not merely as an educational support tool but as a transformative pedagogical agent that promotes psychological resilience, reduces avoidance behaviors, and cultivates sustainability as a core entrepreneurial skill. The partial mediation of fear highlights the nuanced impact of AI: it enhances short-term confidence while simultaneously encouraging a long-term orientation toward value creation, encompassing social and environmental considerations. The study's context - universities in the Middle East, specifically Jordan - is especially relevant. While AI in entrepreneurship education has been studied in Western and East Asian contexts, there is limited research on generative AI applications in under-explored regions. Our findings demonstrate that AI can effectively engage students even in settings with constrained educational resources and heightened socio-economic instability. This contributes to a broader understanding of cross-cultural transferability of AI in education and underscores its potential to positively influence sustainable entrepreneurial intentions and resilience across diverse cultural and institutional environments [50]. From a policy perspective, these results have significant implications for regions with high youth unemployment and limited entrepreneurial opportunities, such as the Middle East and North Africa. Incorporating AI into curricula strengthens student resilience, enhances self-confidence, and directs entrepreneurial intentions toward sustainable value creation. AI is therefore not a resource exclusive to developed countries; it can support youth initiatives and nurture emerging entrepreneurial ecosystems in growing economies. Moreover, AI introduces new avenues for skill development, including personalized learning paths, business scenario simulations, adaptive assignments, and structured thinking exercises. These tools are likely to become standard in preparing the next generation of entrepreneurs, fostering strategic thinking, critical reasoning, the ability to manage uncertainty, and decision-making based on complex evidence. By harmonizing cognitive processes, emotional awareness, and practical knowledge, AI significantly contributes to the cultivation of sustainable entrepreneurial intentions. Finally, this study reinforces the role of AI as a catalyst for changing learning cultures within universities. Smart tools engage students actively, shift teacher attention, and enable personalized instruction, progress tracking, and methodological innovation. These applications not only enhance learning effectiveness but also reduce the likelihood of teacher burnout, ultimately creating a more dynamic and responsive educational environment.

Conclusions

Although entrepreneurship education remains fundamentally modern, it is increasingly shaped by digitalization and the integration of artificial intelligence (AI). Most courses aim not only to provide technical skills but also to introduce basic business concepts, preparing students for future careers. One significant development has been the incorporation of AI into teaching strategic thinking, critical analysis, and decision-making under conditions of uncertainty.AI enables students to engage with simulated business scenarios, often designed to reflect the realities of a globalized, information-driven economy. These simulations provide personalized feedback, allowing learners to explore alternative approaches, test hypotheses, and refine strategies in a safe environment. Such interactive learning encourages student initiative and deepens understanding. The greatest value arises when institutions design courses that go beyond technical skills, fostering comprehensive competencies that prepare students to succeed in modern entrepreneurial contexts. By combining practical tools with cognitive and strategic development, AI-supported education helps cultivate the versatile, adaptable mindset required for contemporary entrepreneurship.

Observational evidence suggests that fear of failure, which often manifests as anxiety, represents a significant barrier for students aspiring to entrepreneurship. This anxiety can hinder their willingness to engage in business activities. However, AI-based educational tools - such as simulations and scenario-based exercises - can provide a safer environment for students to experiment, offering a "universal toolkit" for applying business knowledge drawn from practical experience. Developing self-confidence is critical, as students who trust in their skills are better able to navigate challenges, even while managing concerns about social judgment.

Educational interventions that address both psychological and behavioral aspects are therefore essential. The AI-enhanced entrepreneurship learning model incorporates animated scenarios, adaptable exercises, real-time feedback, and hands-on experiences where students can safely make mistakes. Integrating the Theory of Planned Behavior (TPB) with Defense Motivation Theory (DMT) helps reduce psychological barriers and promotes socially and environmentally responsible behavior. Empirical testing of this methodology indicates that strategically oriented students gain confidence in their knowledge, reduce anxiety, and develop more effective learning habits. Importantly, this approach simultaneously addresses cognitive, emotional, and practical dimensions, supporting curricula designed to produce graduates proficient in sustainable entrepreneurship.

AI in entrepreneurship education should systematically focus on cognitive, emotional, and volitional aspects of learning. Through customized simulations and instant feedback, AI allows students to experiment without fear, gradually building their capacity for independent decision-making and sustainable entrepreneurial intentions. Universities play a crucial role in providing the platforms and teaching materials necessary for this type of education. By integrating these technological advances into practical programs, institutions can enhance educational quality, strengthen student resilience, and encourage value-driven, sustainable entrepreneurship. Ultimately, bridging theory and practice in this way ensures continuity in professional development and adaptability in an ever-changing business environment.

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