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Entrepreneurial Education and Entrepreneurial Success: The Mediating Role of Learner Autonomy and the Moderating Influence of Digital Literacy

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Abstract. This study investigates how learner autonomy and digital literacy collectively bridge the gap between entrepreneurial education and entrepreneurial success. Employing a quantitative approach, this research was conducted in Tehran, Iran, with a sample of 200 entrepreneurial graduates selected through stratified random sampling. Data collected via questionnaires were analyzed using Structural Equation Modeling (SEM). The conceptual model is grounded in frameworks such as the theory of planned behavior (TPB), human value theory and autonomous learning theory, alongside recent research on digital transformation, and posits that while entrepreneurial education directly enhances success and fosters autonomy, the efficacy of autonomous learning in achieving superior entrepreneurial outcomes is moderated by digital literacy. Not only do the findings confirm the direct role of entrepreneurial education and the mediating role of learner autonomy but they also reveal that digital literacy significantly strengthens the relationship between learner autonomy and entrepreneurial success. These results offer significant theoretical implications for the literature on entrepreneurial behavior and autonomous learning. Furthermore, they provide practical guidance for educators, curriculum designers and policymakers, emphasizing that the simultaneous development of both individual autonomy and digital skills is critical for maximizing the effectiveness of entrepreneurial education programs.

Keywords: Entrepreneurial education; entrepreneurial success; autonomous learning; micro, small; and medium enterprises (MSMEs); digital literacy

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1. Introduction

Entrepreneurship has emerged as a critical driver of economic development, particularly in developing countries, where MSMEs contribute significantly to employment and the gross domestic product (GDP). Indeed, MSMEs account for more than 90% of private enterprises in developing countries, providing 60% of total employment and contributing up to 40% of GDP (Bashir, 2020; Nungsari et al., 2023). Consequently, they are crucial for economic development, employment generation and poverty alleviation (Obschonka et al., 2017). As a result, many countries have increasingly been focusing on promoting entrepreneurship in order to foster the expansion and standardization of MSMEs (Nungsari et al., 2023). As entrepreneurship is believed to be a key driver of economic growth (Obschonka et al., 2017; Shir et al., 2018), policymakers are encouraging entrepreneurial behavior among young people to attain financial, cultural and social advantages (Ho et al., 2018; Santika et al., 2022).

In response, entrepreneurial education (EE) has become a primary global strategy for cultivating the necessary skills and mindsets for a future workforce (Munawar et al., 2023). EE programs in higher institutions have expanded rapidly worldwide, with governments viewing them as essential for promoting entrepreneurship (Cui & Bell, 2022; Nungsari et al., 2023). According to the Global Entrepreneurship Monitor (2021), EE instills an entrepreneurial mindset and equips individuals with skills such as creativity, leadership and problem-solving (Banha et al., 2022). This focus was highlighted as early as UNESCO's International Symposium on Education for the 21st Century, which identified EE as a vital component for development innovation (Ratten & Usmanij, 2021); this priority was echoed by the European Commission.

Although this global momentum provides a framework for national policies, the successful implementation of such educational initiatives often depends on the unique socio-economic context of each country. In such nations as Iran, which are actively working to diversify their economies and raise innovation, understanding how these global educational trends translate into local entrepreneurial outcomes is of paramount importance. Iran's push for entrepreneurship aligns with these international trends, prompting universities to integrate EE within a national 'mass entrepreneurship and innovation' initiative, supported by government leadership and financial backing (Chien et al., 2020).

Despite these significant investments in EE and a corresponding high level of student interest – with 96.1% expressing entrepreneurial intention in 2021 (Mao, 2021) – a stark “intention-action gap” persists. In 2023, the actual startup rate was only 13.2% (Zhilianzhaopin, 2023), indicating that educational programs alone are insufficient to convert aspirations into attainment. Therefore, this study seeks to provide a more thorough understanding of the factors that facilitate the translation of EE into tangible success. Specifically, it investigates why existing models, which often focus on education and intrinsic motivations such as learner autonomy, fail to explain this gap, suggesting that a critical modern competency – digital literacy – may be a missing link.

Therefore, the purpose of this study is to develop and test a more comprehensive model of entrepreneurial success by examining the interconnected roles of EE, learner autonomy and digital literacy. This research holds significance for the literature on the topic by being among the first to investigate the moderating effect of digital literacy on the relationship between learner autonomy and entrepreneurial success within this framework. By integrating this contemporary skill, the study aims to provide a more delicate understanding of the entrepreneurial process in the digital age. As well as deepening understanding, the findings are intended to offer actionable insights for educators and policymakers to design more effective educational ecosystems that can not only promoted intent but also equip aspiring entrepreneurs with the complete skill set needed to succeed.

2. Theoretical Framework

2.1 Theory of Planned Behavior (TPB) and Entrepreneurial Education (EE)

For years, research on entrepreneurial behavior has primarily focused on the factors influencing entrepreneurial intention, guided by the foundational belief that intention directly precedes and correlates with action (Ajzen, 1985; Rohanaraj, 2023). Ajzen's (1985) theory of planned behavior (TPB) has been the most prominent framework in this domain, explaining the ways in which attitudes, subjective norms and perceived behavioral control collectively shape intention (Rohanaraj, 2023). However, while TPB is useful, the complexity of the entrepreneurial process, which involves dynamic and sustained action beyond mere intention, necessitates a broader theoretical lens (Cui & Bell, 2022). Therefore, this study builds upon the foundation of TPB by integrating additional theoretical perspectives through which to explore the post-intention factors that directly contribute to tangible entrepreneurial success.

2.2 Human Value Theory and Entrepreneurial Success

By explaining how entrepreneurs define and measure their own success, the human value theory provides a critical framework for this study. Values serve as a fundamental driver of motivation, shaping an individual's goals and decision-making (Gorgievski et al., 2011). Building on the foundational work of Rokeach (1973) and Schwartz and Bilsky (1990), research in entrepreneurship has demonstrated that business owners' evaluations of success are directly aligned with their underlying value orientations, such as personal satisfaction (person-oriented) or profitability and social impact (business-oriented) (Gorgievski et al., 2011). Therefore, this theory justifies the adoption of a multi-dimensional measure of success, and this paper utilizes the Subjective Entrepreneurial Success Scale, which is grounded in this perspective to assess entrepreneurial achievement (Dej, 2010).

2.3 Autonomous Learning Theory and Learner Autonomy

Originating from adult education, autonomous learning theory provides theoretical basis for understanding learner autonomy as a critical psychological resource for entrepreneurs (Knowles, 1975). Early theories categorized adult learners by their orientation, with the most self-driven seeking knowledge for

intrinsic purposes (Meyer, 2001). Modern research confirms that such autonomous motivation is strongly correlated with higher engagement, persistence, creativity, deep learning, and personal goal attainment (Niemic & Ryan, 2009; Sheldon & Elliot, 1998).

This study conceptualizes learner autonomy through the conative factors of desire, resourcefulness, initiative and persistence, as measured by the Learner Profile Questionnaire (Confessore & Confessore, 1992). Each construct is vital for entrepreneurs: desire fuels navigation through challenges; resourcefulness drives learning; initiative leads to goal setting; and persistence ensures action despite obstacles (Carr, 1999; Derrick, 2001). Since entrepreneurs constantly face uncertainty and risk, cultivating a robust capacity for such self-directed action is essential for navigating their journey and achieving success (van Gelderen, 2010). Thus, autonomous learning theory is integral to our model as it frames learner autonomy not merely as an educational outcome, but as a core competency needed for entrepreneurial effectiveness.

2.4 EE and Entrepreneurial Success

The relationship between EE and its tangible impact on success is a central, yet debated, topic in literature. The core premise of EE is to transform intentions into actionable outcomes by equipping individuals with an entrepreneurial mindset and skills (Banha et al., 2022). Recent studies provide evidence supporting this, demonstrating that EE can directly enhance entrepreneurial behavior and foster an attitude linked with professional success (Cui et al., 2021; Munawar et al., 2023).

However, the impact of EE is not universally accepted as being positive. Indeed, the literature presents an equivocal picture, with some research highlighting that EE can have a neutral or even negative effect, possibly by exposing students to the true challenges of entrepreneurship (Fayolle & Gailly, 2015; Oosterbeek et al., 2010). This ongoing debate underscores the need for further investigation into the mechanisms that determine EE's effectiveness (Othman & Othman, 2019). Despite the mixed findings, the prevailing objective and theoretical assumption of EE programs is that they positively contribute to entrepreneurial capabilities.

H1: EE is positively related to entrepreneurial success.

2.5 EE and Learner Autonomy

A key objective of modern EE should be the cultivation of autonomy (van Gelderen, 2010). Education is intrinsically linked to fostering autonomy, as it empowers individuals with the knowledge and confidence needed for independent decision-making—a cornerstone of entrepreneurship (Stouraitis et al., 2020). Scholars argue that because entrepreneurs must operate with significant freedom and adapt to dynamic environments, EE curricula must be designed to explicitly develop this capacity for self-governance and proactive learning (van Gelderen, 2010). Therefore, it is theoretically consistent to propose that formal education in entrepreneurship serves as a direct antecedent to an individual's level of learner autonomy.

H2: EE is positively related to learner autonomy.

2.6 Learner Autonomy in Entrepreneurship/Entrepreneurial Success

Learner autonomy, defined as the capacity for intentional, self-directed learning, is a powerful predictor of achievement (Bandura, 2001; Confessore & Confessore, 1992). The core skills associated with autonomy—taking initiative, being resourceful and demonstrating persistence—are not merely academic traits; they are the essential behaviors required to navigate the high-risk, uncertain journey of an entrepreneur. An ability to independently manage one's learning and development allows an entrepreneur to effectively identify and exploit opportunities, solve novel problems, and persevere through setbacks (Confessore, 2006). Consequently, learner autonomy is theorized to be a direct and positive determinant of entrepreneurial success.

H3: Learner autonomy is positively related to entrepreneurial success.

2.7 The Mediating Role of Learner Autonomy

While EE provides foundational knowledge and skills, its ultimate success may depend on an intermediate mechanism to translate this learning into effective entrepreneurial action. This study posits that learner autonomy fulfills this critical role of mediating variable. Entrepreneurship education strengthens participants' competencies, which in turn makes them more autonomous and better equipped to create new ventures. In essence, EE provides the "what" (e.g. business planning, market analysis), but learner autonomy provides the "how", including the internal drive, resourcefulness and persistence needed to apply that knowledge in dynamic, real-world scenarios. Therefore, we propose that EE promotes success not only directly, but also indirectly, by enhancing the learner's capacity for autonomous action (Galvão et al., 2020).

H4: Learner autonomy mediates the relationship between EE and entrepreneurial success.

2.8 The Moderating Role of Digital Literacy

In the contemporary digital economy, the practical value of learner autonomy is amplified by an entrepreneur's digital literacy. Digital literacy, the ability to find, evaluate and utilize information via digital platforms—has become an indispensable competency for modern entrepreneurs (Thompson, 2022). An autonomous learner who is also digitally literate can more effectively leverage digital marketing, manage data and access online networks to advance their venture (Rossi et al., 2023). We argue that digital literacy acts as a catalyst; it strengthens the positive impact of learner autonomy on success.

In other words, the benefits of being a persistent and resourceful learner are maximized when the entrepreneur also has the necessary digital tools and skills to execute those traits in the modern marketplace. While autonomous learning theory effectively explains why autonomy is a critical psychological resource for entrepreneurs, it does not fully account for how the efficacy of this personal trait varies across different business environments, particularly in today's digital economy. To provide a deeper understanding, this study draws upon the dynamic capabilities view as a complementary theoretical lens. Introduced by Teece et al. (1997), the dynamic capabilities framework posits that sustainable competitive advantage in volatile and uncertain environments stems from a firm's (or an entrepreneur's) ability to integrate, build and reconfigure internal

and external competencies. In other words, success depends on the ability to “sense” opportunities and threats, “seize” these opportunities, and “transform” existing resources to maintain competitiveness. Within the model of this study, learner autonomy can be conceptualized as a foundational personal capability that drives the “sensing” process. Autonomous entrepreneurs are inherently inclined to learn, be curious and seek out new opportunities to navigate challenges and achieve their goals.

However, in the digital era, merely “sensing” an opportunity is insufficient. The ability to “seize” that opportunity and “transform” the business model is heavily dependent on technological tools. This is where digital literacy emerges as a critical operational capability. It equips entrepreneurs with the necessary tools to execute ideas in a digital landscape, including analyzing online market data, leveraging digital marketing, managing e-commerce platforms and optimizing business processes. Therefore, from the perspective of dynamic capabilities, digital literacy is not just an independent skill but an enabling mechanism that enhances the effectiveness of learner autonomy.

An entrepreneur who is autonomous but lacks digital literacy may identify opportunities but will be less effective in capitalizing on them. Conversely, an autonomous and digitally literate entrepreneur can rapidly and efficiently translate their knowledge into successful business actions in the modern marketplace. This theoretical framework underpins the hypothesis that digital literacy positively moderates the relationship between learner autonomy and entrepreneurial success (Ritter & Pedersen, 2020).

H5: Digital literacy moderates the relationship between learner autonomy and entrepreneurial success, such that the effect is stronger for entrepreneurs with higher digital literacy.

The hypothesized model is presented in Figure 1.

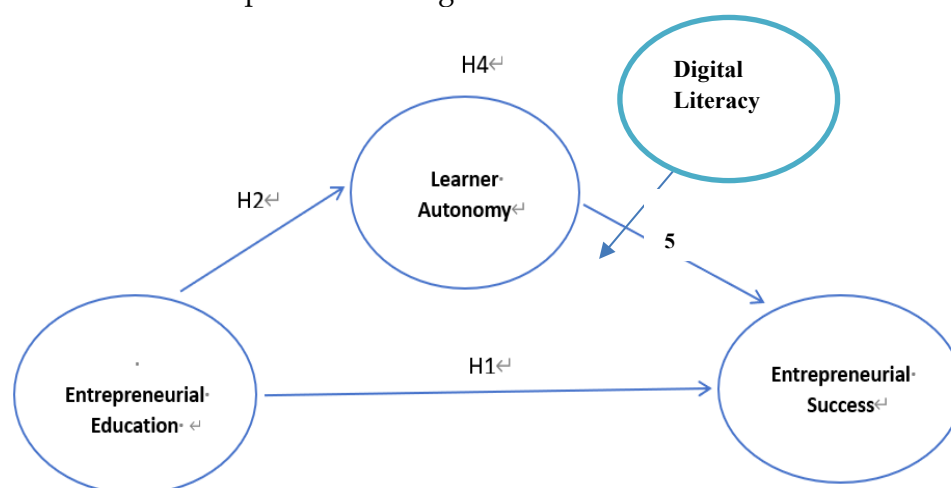


Figure 1: Hypothesized model

3. Research Design

3.1. Research Design and Sampling Procedure

This research employed a quantitative, cross-sectional design using a survey method to examine entrepreneurs' reflections on their educational experiences and current level of success. The study sought to test the hypothesized model's ability to explain how EE, learner autonomy and digital literacy contribute to entrepreneurial success.

This study adopts a retrospective design, which collects data on past events and experiences—in this case, the perceived impact of prior entrepreneurial education—from participants at a single point in time. This approach was deemed suitable as it allows for the efficient collection of data connecting educational antecedents with current entrepreneurial outcomes while avoiding the time and resource constraints of longitudinal study (Saunders et al., 2009).

The target population for this research was university graduates in Tehran Province, Iran, who had previously participated in entrepreneurship education and were actively managing their own ventures. The region contains approximately 70 colleges and universities, providing a rich pool of potential participants. Using university networks and with support from faculty, questionnaires were distributed to 220 graduate entrepreneurs. The survey was conducted from September to December 2024. To ensure linguistic and cultural accuracy, the questionnaire, having been originally drafted in English, underwent a rigorous back-translation process. All participants were assured of the confidentiality and anonymity of their data and their voluntary right to withdraw at any stage.

Table 1: Demographic Information

Demographic Constructs	Option	Frequency (n=200)	Percentage (%)
Gender	Male	120	54.60%
	Female	80	45.40%
	Other (third gender)	0	0.00%
Age	Under 23 years old	50	33.90%
	24-36 years old	100	65.60%
	Over 37 years old	50	0.50%
Highest education level	Below Undergraduate	40	31.70%
	Bachelor's degree	100	47.30%
	Master's degree	20	13.70%
	Doctorate	40	7.30%

A final sample of 200 valid responses was collected, yielding a high response rate of 90.9%. Participants were less than 23 years old, with a relatively balanced

gender distribution (54.6% male, 45.4% female). The majority of respondents fell within the age range of 24 to 36, representing 65.6% of the total, while 33.9% were under 23 years old. Respondents included all types of university graduates; undergraduate and lower levels accounted for 31.7% and 47.3%, while master's and doctoral students accounted for 13.7% and 7.3%, respectively. The largest group of professionals had studied humanities and social sciences, comprising 34.1%. Natural sciences followed closely with 22.4%.

3.2. Measures and Operational Definitions

The study's questionnaire consisted of previously validated scales and a section for demographic information. All constructs were measured using a 5-point Likert scale unless otherwise noted.

- **Operational Definition of EE:** In this study, EE is operationally defined as the extent to which alumni perceive their formal education as having provided them with the necessary values, skills, networks and inspiration to pursue and succeed in an entrepreneurial career. This was measured using a 22-item scale adapted from Johannisson (1991) and Souitaris et al. (2007).
- **Operational Definition of Learner Autonomy:** Learner autonomy is operationally defined as the self-perceived psychological capacity of an individual to direct their own learning. It is characterized by their initiative, persistence, resourcefulness in identifying and using learning resources, and the intrinsic desire to learn. This was assessed using the 66-item Learner Autonomy Profile-Short Form (LAP-SF) (Confessore, 2006).
- **Operational Definition of Entrepreneurial Success:** Entrepreneurial success is operationally defined as an entrepreneur's subjective evaluation of their achievement across multiple personal and business-related domains. This includes their perceived performance regarding company growth, quality of workplace relations, community impact, personal financial rewards and personal fulfillment. This was measured using the 24-item Subjective Entrepreneurial Success Scale (Wach et al., 2016).
- **Operational Definition of Digital Literacy:** Digital Literacy is operationally defined as an entrepreneur's self-assessed competence in using digital tools and online platforms to identify opportunities, manage business operations and create value. For the purpose of the model, this was measured using a scale adapted from the recent literature on digital entrepreneurship competencies.

3.3. Instrument Validity and Reliability

To ensure the validity and reliability of the measurement instruments, the following procedures were rigorously followed.

- **Validity:** Content validity was established by adopting scales from highly cited, peer-reviewed international literature (Wach et al., 2016), ensuring that the items were both relevant and comprehensive. Including the back-translation process further confirmed that the content validity of the instrument was maintained in the Persian context. Construct validity,

comprising both convergent and discriminant validity, was assessed during the PLS-SEM analysis. Convergent validity was confirmed by examining the average variance extracted (AVE) and composite reliability (CR), while discriminator validity was assessed using the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio.

- **Reliability:** The internal consistency of the scales was evaluated using Cronbach's alpha (CA). CA is a method commonly used to assess a measurement tool's internal consistency. It indicates how well the items within a group align, with a high level of alignment suggesting they measure the same concept effectively. In this study, the results indicated excellent reliability for all major constructions. The EE scale showed a CA of 0.911, the entrepreneurial success scale revealed a CA of 0.897, and the learner autonomy scale yielded a CA of 0.961. As all values were well above the recommended threshold of 0.70, the reliability of the measures was confirmed.

Table 2: CA of Variables

Variables	Cronbach's Alpha	No. of Items
EE	.911	22
Learner Autonomy	.961	66
Entrepreneurial Success	.897	24
Digital Literacy	.852	10

3.4. Data Analysis

Data analysis was performed using two statistical software packages. First, descriptive statistics—including frequencies and demographic distributions—were calculated using SPSS Statistics 28. Second, the conceptual model was tested, and the research hypotheses were evaluated using the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique, which was executed with Smart-PLS 4 software. The analysis included assessing the measurement model for validity and reliability, followed by testing the structural model pathways and bootstrapping to determine the significance of the hypothesized relationships.

The selection of PLS-SEM over other covariance-based SEM (CB-SEM) approaches was justified for several reasons. First, the primary goal of this research is prediction-oriented, as it seeks to identify the key factors that contribute to entrepreneurial success; this is a task for which PLS-SEM is particularly well-suited. Second, the research model is relatively complex, incorporating both mediation and moderation effects, which are effectively handled by the PLS-SEM algorithm. Finally, PLS-SEM is a robust measure to determine non-normal data distributions and is effective with moderate sample sizes such as that used in this study (N=200), making it the most appropriate analytical selection (Hair et al., 2013).

4. Data Analysis

This study employed SPSS 26.0 and PLS-SEM for data analysis. Because this is a quantitative study, statistical programs were employed. The data were analyzed using descriptive statistics, confirmatory factor analysis, internal consistency reliability, indicator loadings, convergent validity and discriminant validity. Specifically, demographic data were summarized through descriptive statistics such as frequencies and percentages. Next, factor loading, CA, CR, convergent validity (AVE), and discriminant validity for the measurement model were assessed. Finally, in order to evaluate the structural equation model, the coefficient of determination, effect size and path coefficients were calculated using PLS-SEM.

In summary, this paper outlines the methodological strategy for investigating the impact of EE on entrepreneurial success among participants in Tehran Province, Iran. Participants were selected through random and snowball sampling techniques, thereby ensuring an accurate representation of the population, while a structured questionnaire served as the main data collection tool, having been refined through pilot testing. The analysis emphasized statistical techniques, including descriptive statistics, correlation and regression, with a strong focus on validity and reliability to enhance the robustness of the findings.

Table 3: Descriptive Statistics

Constructs	Option	Frequency (n=200)	Percentage (%)
Founding date of the company	During university	60	30.0%
	1-5 years after university	100	50.0%
	6-10 years after university	40	20.0%
Business field	Digital entrepreneurship (internet-related)	40	20.0%
	Manufacturing and industry (including construction)	45	23.0%
	Agriculture and food	31	16.0%
	Medicine, health and life sciences	25	13.0%
	Energy and environment	15	8.0%
	services	44	22.0%
Duration of the company	Less than 3 years	66	33.0%
	3-10 years	105	53.0%
	Over 10 years	29	15.0%
The usefulness of university education for entrepreneurship	Very helpful	55	28.0%
	Quite helpful	45	23.0%
	Average	35	18.0%
	Not very helpful	44	22.0%
	Not at all helpful	21	11.0%

As can be seen in Table 3 above, a significant portion of the entrepreneurs had established their businesses while in college (30%) while 50% set up their businesses between one- and five-years post-graduation, and the rest (20%) established their companies between six and ten years after graduation.

The measurement model analysis includes four key phases: checking indicator reliability with factor loadings over 0.7; ensuring internal consistencies with CR are greater than 0.7; confirming convergent validity with AVE above 0.5; and checking discriminate validity between constructs with an HTMT ratio of 0.85.

A measurement model's trustworthiness depends on factor loadings, which measure the strength of the link between visible variables and their hidden causes. These loadings illustrate the tightness of the connection between observed and hidden factors. A measurement model is considered reliable if each item has a loading of 0.7 or higher and shows statistical significance at the 0.05 level (Fornell & Larcker, 1981).

This research found that the factor loading coefficients of most variables were in the high range (>0.7), which indicated that the strengths of the relationships between the observed variables and their corresponding latent variables were all high. According to Kock and Lynn (2012), factor loadings above 0.7 are considered ideal, as they explain a large portion of the variance in the observed variable. Factor loadings between 0.4 and 0.7 remain acceptable, though they suggest that the variable is only moderately related to the factor. According to the results, all of the items used for this study demonstrated satisfactory indicator reliability. Table 4 shows the CR scores of each variable.

Table 4: CA and CR

Construct Name	Items	CR (>0.7)
EE	Inspiration	0.914
	Learning	0.891
	Access to incubation resources	0.940
LA	Desire to learn	0.966
	Initiative	0.942
	Resourcefulness	0.965
	Persistence	0.918
ES	Firm performance	0.884
	Workplace relations	0.902
	Personal fulfillment	0.928
	Community impact	0.885
	Personal financial rewards	0.879
DL	Critical	0.891
	Operational	0.940
	Cognitive	0.942
	Emotional	0.965
	Social	0.902

Note : EE=entrepreneurial education; LA=learner autonomy; ES=entrepreneurial success; DL= digital literacy

As can be seen in Table 5, the CR scores for all latent variables were at relatively high levels, and all were higher than 0.7, indicating that these latent variables possessed good reliability. Convergent validity is one of two crucial concepts in evaluating confirmatory factor analysis, which is used to determine whether constructions or factors can be appropriately measured and distinguished. Convergent validity can be evaluated using two key approaches: factor loadings, which measure the intensity of the link between the observed variables and hidden factors; and average variance extracted (AVE), a metric presented in Table 5, which is used to determine the average percentage of variation in the observable variables attributed to each latent factor.

Table 5: Average variance extracted

Construct Name	Items	AVE (>0.5)
Entrepreneurial Education	Inspiration	0.640
	Learning	0.620
	Access to incubation resources	0.589
Learner Autonomy	Desire to learn	0.575
	Initiative	0.522
	Resourcefulness	0.567
	Persistence	0.555
Entrepreneurial Success	Firm performance	0.605
	Workplace relations	0.605
	Personal fulfillment	0.618
	Community impact	0.720
	Personal financial rewards	0.785
Digital Literacy	Critical	0.620
	Operational	0.589
	Cognitive	0.567
	Emotional	0.555
	Social	0.640

According to Fornell and Larcker's criterion, an AVE value above 0.5 is generally considered acceptable, with anything above 0.7 being considered good (Fornell & Larcker, 1981). As presented in Table 6, the AVE values of the latent variables were 0.522-0.785, indicating that these latent variables possess good convergent validity. Discriminant validity is another concept in evaluating confirmatory factor analysis, which ensures that a latent factor stands out clearly from other factors in a multi-measure study. According to Fornell and Larcker's criterion, the square root of the AVE (diagonal values) for each construct should be greater than the corresponding correlation coefficients, demonstrating sufficient discriminant validity (Fornell & Larcker, 1981). The results of this step are shown in Table 6, representing the square roots of the AVE and the inter-correlation values between constructs.

Table 6: Discriminant validity-the square root of AVE and correlation coefficients

Construct Name	Items	The square root of AVE	Row maximum	Column maximum	Maximum
EE	Learning	0.800	0.645	0.423	0.645
	Inspiration	0.787	0.399	0.405	0.405
	Access to incubation resources	0.767	0.323	-	0.323
LA	Desire to learn	0.758	0.303	0.362	0.362
	Initiative	0.722	0.339	0.405	0.405
	Resourcefulness	0.753	0.390	0.262	0.390
	Persistence	0.745	0.466	0.390	0.466
ES	Firm performance	0.778	0.448	-	0.448
	Workplace relations	0.778	0.466	0.398	0.466
	Personal fulfillment	0.786	0.442	0.459	0.459
	Community impact	0.849	0.448	0.334	0.448
	Personal financial rewards	0.778	0.448	-	0.448
DL	Critical	0.722	0.339	0.405	0.405
	Operational	0.753	0.390	0.262	0.390
	Cognitive	0.849	0.448	0.334	0.448
	Emotional	0.800	0.645	0.423	0.645
	Social	0.753	0.390	0.262	0.390

Note : EE=entrepreneurial education; LA=learner autonomy; ES=entrepreneurial success; DL= digital literacy

According to Table 6, the square roots of the AVE for all variables were greater than the maximum absolute values of the inter-factor correlation coefficients, or all off-diagonal elements were lower than the square roots of AVE, indicating that there was good discriminant validity among the variables. Hence, the results confirmed that Fornell and Larker's criterion had been met. The following section explains the direct relationship between the three variables, the indirect relationship through the mediator, digital literacy and the strength of the mediator to identify the mediating role of digital literacy.

4.1 The direct relationship between EE and ES

The first research objective was to explore the relationship between EE and entrepreneurial success, addressing the following question: How does EE impact entrepreneurial success? According to the data, the path coefficient of 0.299 indicates a positive direct effect of EE on entrepreneurial success, with a t-value of 6.480 ($\beta=0.299$; $p=0.000$), confirming its significant impact. Therefore, H1 is supported (as indicated in Table 7). This aligns with studies by Kolstad and Wiig (2011), Dickson and Weaver(2011), and Maziriri et al. (2024), which emphasize

the role of EE in improving access to funding, business growth, and market readiness (Dickson & Weaver, 2011; Kolstad & Wiig, 2011; Maziriri et al., 2024).

4.2 The direct relationship between LA and ES, EE and LA

Next, the direct effect between EE-LA (shown in Table 8) indicates that entrepreneurial education is positively related to learner autonomy ($\beta=0.529$; $t=13.668$, $t>1.645$; $p=0.000$, $p<0.05$), indicating that H2 is supported. This finding is supported by the work of van Gelderen (2010) and Stouraitis et al. (2020), who demonstrated that autonomy is strongly associated with entrepreneurship.

Additionally, the second research objective was to examine the relationship between learner autonomy (LA) and entrepreneurial success (ES). Based on the data analysis, the path coefficient of LA and ES was found to be 0.169, indicating a modest positive effect of learner autonomy on entrepreneurial success, with a t-value of 3.782, confirming a significant relationship. Thus, the direct effect results show that LA positively affects ESs ($\beta=0.169$; $t=3.782$, $t>1.645$; $p=0.000$, $p<0.05$), and consequently H3 is supported (see Table 8). This finding aligns with studies by Confessore and Park (2002), and Foen Ng et al. (2012), showing that LA enhances entrepreneurial performance/success through optimizing resources.

Table 7: Hypothesis Testing Direct Effects

Hypotheses	Relationship	Std. Beta	STDEV	T values	P-values	PCI	PCI	f2	Results
						LL	UL		
						5%	95%		
H1	EE ->ES	0.299	0.043	6.899	0.000	0.227	0.369	0.106	supported
H2	EE ->LA	0.529	0.039	13.668	0.000	0.466	0.592	0.387	supported
H3	LA ->ES	0.169	0.045	3.782	0.000	0.093	0.243	0.041	supported

Table 8: Hypothesis Testing Indirect Effects

Hypotheses	Relationship	Std. Beta	Standard deviation (STDEV)	T values	P-values	PCI	PCI	Results
		(>0.05)				LL	UL	
						5%	95%	
H4	EE->LA ->ES	0.089	0.024	3.750	0.000	0.050	0.130	supported

Note: This research uses a 95% confidence interval and one-tailed type with a bootstrapping of 5,000. The study's research hypotheses were tested based on the values of the t-stats. They suggest that t-stat values must be >1.645 and p-values <0.05 .

Table 9: Hypothesis Testing Moderate Effects

Hypotheses	Relationship	Std. Beta	Standard deviation (STDEV)	T values	P-values	PCI LL	PCI UL	Results
		(>0.05)				5%	95%	
H5	LA->DL ->ES	0.529	0.039	13.668	0.000	0.466	0.592	supported

Note: This research uses a 95% confidence interval and one-tailed type with a bootstrapping of 5,000. The study's research hypotheses were tested based on the values of the t-stats. They suggest that t-stat values must be >1.645 and p-values <0.05.

4.3 The indirect effect of EE on ES through LA

Furthermore, the third research objective was to assess the mediating role of LA in the relationship between EE and ESs. The study found that LA partially mediates this relationship, with EE influencing ESs both directly and indirectly through LA. In order to measure this mediation, the research calculated the indirect effect by multiplying the two path coefficients ($0.529 \times 0.169 = 0.089$). The total effect of EE on success was found to be 0.388, combining the direct effect (0.299) and the indirect effect (0.089). The indirect effect, with a β value of 0.089 and p-value of 0.000, confirms the significance of the mediation. This suggests that EE enhances LA, which in turn contributes to ESs, though EE also maintains a direct influence on success. Since the mediating effect of LA was 0.089, with a 95% confidence interval [0.050, 0.130], which excluded 0, H4 was also verified (as shown in Table 8).

4.4 Variance accounted for (VAF) for LA

According to Hair et al. (2013), the variance accounted for (VAF) is used to measure the strength of the mediation. In this study, the VAF was 22.94%, meaning that 22.94% of the total effect is explained by the mediation of LA. Since the VAF falls between 20% and 80%, this indicates partial mediation.

In conclusion, LA partially mediates the relationship between EE and ESs, with 22.94% of the effect being mediated, while the direct effect remains significant (see Table 10). This finding aligns with those in studies by Van Gelderen (2010), Kgagara (2011), Stouraitis et al. (2020), and Munawar et al. (2023), which also found that autonomy plays a key role in education, with functional LA contributing to the use of resources and leading to ESs.

4.5 The moderate effect of DL on related LA with ES

The analysis also tested the fifth hypothesis (H5), which proposed that digital literacy moderates the relationship between LA and ESs. The results provide strong support for this moderating effect. As shown in the results Table 9, the interaction term between LA and digital literacy was found to have a significant and positive effect on ESs ($\beta = 0.529$; $T = 13.668$; $p < 0.001$). This finding indicates that the positive relationship between LA and ESs is conditional upon the level of an individual's digital literacy. Specifically, the positive nature of the interaction demonstrates that for entrepreneurs with a higher level of digital literacy, the positive impact of LA on their ESs is significantly strengthened.

In practical terms, this means that while LA is inherently valuable, its translation into tangible success is substantially amplified when entrepreneurs also possess the competence to leverage digital tools and platforms effectively. The most significant and unique finding of this study is the confirmation of the moderating and enhancing role of digital literacy in the relationship between LA and ESs. This result responds to recent calls in the literature for a re-evaluation of traditional models of ESs in the digital age. Our findings indicate that LA and digital literacy do not operate in isolation but in a synergistic interplay, a notion this study is among the first to empirically test.

In other words, the value of a key psychological resource like autonomy is significantly amplified and reaches its full potential within a technologically rich environment. This finding lends empirical support to the dynamic capabilities view; in this framework, autonomy assists the entrepreneur in “sensing” opportunities, while digital literacy provides the “operational capability” necessary to “seize” and capitalize on those opportunities in a digital market. For instance, an entrepreneur with a strong motivation to learn (high autonomy) might identify a new market need, but this insight only translates into tangible success if they also possess the digital literacy to execute targeted marketing campaigns, analyze customer data and manage an online platform.

Therefore, this research concludes that to foster successful entrepreneurs in today’s economy, policymakers and educational institutions must focus on simultaneously developing both individual autonomy and digital competencies, as success is no longer solely dependent on what entrepreneurs know, but on their capability to act upon that knowledge within a digital landscape.

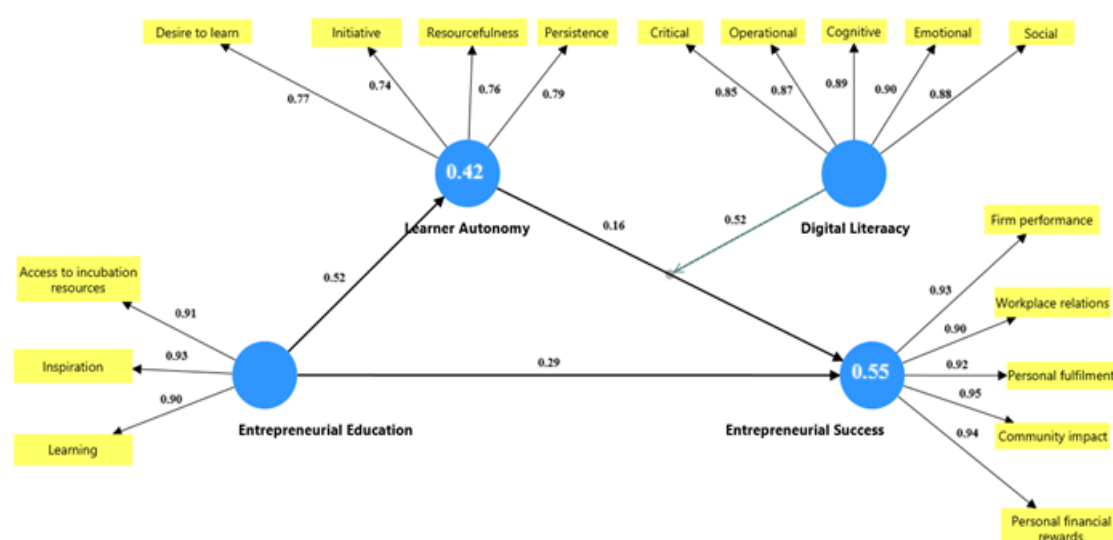


Figure 2: Path Coefficients Model

Table 10: Meditation role of LA

Total effect		Direct effect EE-ES			Indirect effect			
EE-ES					EE-LA-ES			
β	P-value	β	T-value	P-value	β	SD	T-value	P-value
0.388	0.000	0.299	6.899	0.000	0.089	0.024	3.750	0.000
Variance accounted for (VAF)					22.94 % Partial Mediation			
VAF=0.089/0.388*100=22.94					VAF=22.94 % (partial mediation effect)			

Note : LA has a partial mediation effect (22.94 %). EE : entrepreneurial education; ES : entrepreneurial success; LA : learner autonomy

5. Discussion

This section discusses the study's key findings by integrating them with existing literature and theoretical models. First, it addresses how the findings relate to previous research before explicitly outlining the unique contribution of the study with regard to digital issues.

5.1 Discussion of Findings in Relation to Existing Literature

Not only do the findings of this study support existing theories on ESs, but they also extend them. Firstly, the confirmation of a direct, positive relationship between EE and ESs aligns with a significant body of research advocating for the benefits of formal entrepreneurial training (Cui, 2021; Munawar et al., 2023). This result reinforces the argument that structured education equips aspiring entrepreneurs with the knowledge, skills, and networks necessary to launch and sustain a business venture (Ratten & Usmanij, 2021).

Secondly, the study provides strong empirical evidence for the mediating role of LA in the relationship between EE and success. In particular, this finding significantly contributes to literature by demonstrating *how* EE works. It suggests that the value of education lies not only in direct knowledge transfer but, more importantly, in its ability to cultivate a self-directed, resilient, and proactive mindset (Knowles, 1975). Thus, this finding empirically validates the theoretical assertions made by scholars such as van Gelderen (2010), who argued that fostering autonomy should be the central goal of entrepreneurial pedagogy, thereby bridging the gap between educational input and real-world entrepreneurial action.

Finally, the results related to the moderating role of digital literacy introduce a critical new dimension to the discussion. By revealing that the impact of LA on success is amplified by digital skills, the study moves beyond traditional models. This aligns with recent calls to re-evaluate entrepreneurial competencies in the digital age, suggesting that psychological traits and learned skills interact dynamically with technological capabilities to produce successful outcomes (Galvão et al., 2020).

5.2 The Unique Contribution Regarding Digital Issues

Moreover, the primary uniqueness of this research, particularly in relation to digital issues, lies in its conceptualization and empirical validation of digital

literacy as a critical contingent factor, rather than merely as another direct antecedent of success. While previous research has separately acknowledged the importance of psychological traits such as autonomy and the growing need for digital skills (Nambisan, 2017), this study is among the first to model and test synergistic interplay between them. Our findings demonstrate that the value of a key psychosocial resource—learner autonomies is unlocked and amplified in a digitally-rich environment.

Consequently, this moves the conversation from “what factors lead to success?” to “under what conditions are these factors most effective?”. This contribution is particularly significant because it reflects the reality of modern entrepreneurship, whereby self-directed learning (e.g. identifying a new market need) is only as effective as the entrepreneur’s ability to use digital tools (e.g. social media analytics, e-commerce platforms) to act on that learning (Ritter & Pedersen, 2020).

6. Implications of the Study

6.1 Theoretical Implications

Theoretically, this research extends the application of self-directed learning theory (Knowles, 1975) and psychosocial perspectives on entrepreneurship by empirically validating autonomy as a core mechanism through which education can be translated into success. More importantly, by integrating digital literacy as a moderating construct, the study contributes to the development of more dynamic and contemporary models of entrepreneurial competence. Furthermore, it answers recent calls for frameworks that better reflect the complex realities of the digital economy, in which success is often a product of the interaction between internal dispositions and external technological competencies (Nambisan et al., 2019).

6.2 Practical Implications

For Educators and Curriculum Developers: Evidently, the results necessitate a shift from traditional, passive teaching models toward active, experiential learning environments. It is no longer sufficient to teach business theory; curricula must be redesigned to foster autonomy. This can be achieved by implementing problem-based projects, business simulation games, and mandatory ‘venture creation’ modules, whereby students must independently develop a business model, conduct market research using digital tools, and pitch the concept to industry experts. Such approaches would directly cultivate both LA and digital literacy.

For University Policymakers and Administrators: The strong moderating effect of digital literacy suggests that investments in campus-wide digital infrastructure and skills training are critical for maximizing the return on investment in entrepreneurship programs. Therefore, universities should create integrated ecosystems that provide access to digital resources, mentorship from tech entrepreneurs and partnerships with incubators, thereby ensuring that educated and autonomous students can thrive in a modern economy. Such a

focus would move beyond the classroom to build a supportive institutional environment in which to foster aspiring entrepreneurs.

7. Limitations and Future Research

Despite its contributions, this study has certain limitations that offer avenues for future research. The cross-sectional and retrospective nature of the survey design, while useful for capturing a snapshot, is susceptible to recall bias and cannot definitively establish causality over time. Therefore, future studies employing longitudinal designs are needed to track the development of autonomy and success from the educational phase onwards. Additionally, the study's focus on Tehran Province limits the generalizability of its findings. Consequently, cross-cultural research is essential to investigate whether the proposed model holds true in different economic and cultural contexts.

Furthermore, future research could disaggregate the broad constructs of "EE" and "digital literacy" to examine specific pedagogical techniques and digital skills, identifying those that are most impactful. Finally, the use of the 66-item Learner Autonomy Profile-Short Form (LAP-SF), while comprehensive, may have introduced the risk of participant fatigue, potentially affecting the quality of participants' responses, especially in later sections of the questionnaire. Future research could therefore explore the use of more concise, validated scales for measuring LA in order to mitigate this potential issue.

8. Conclusion

In conclusion, this research clarifies the complex pathways linking education to ESs. Specifically, it establishes that the impact of EE is most potent when it simultaneously cultivates a student's intrinsic capacity for self-directed learning and is paired with the essential toolkit of digital literacy. The main conclusion of the study is that, in an increasingly dynamic and digitized world, empowering the next generation of entrepreneurs requires a comprehensive strategy that focuses not only on what they know, but also on their ability to learn independently and to act on that learning within a digital landscape. This integrated perspective is vital for designing educational interventions that can create resilient and successful entrepreneurs for the future.

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