Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Digital entrepreneurship education as a necessary condition for digital entrepreneurial intention among university students in an emerging digital economy

Dang Thien Tam
dangthientam@dtu.edu.vn
Duy Tan University
Nguyen Thi Thu Hang
Duy Tan University
Nguyen Thuy Anh
Duy Tan University
Nguyen Thi Hoai Oanh
Duy Tan University
Tran Truong Dang
Duy Tan University
Dang Thanh Dung
Duy Tan University
Nguyen Huu Vi Thu
Duy Tan University
Ha Thi Duy Linh
Duy Tan University

Research Article

Keywords: digital entrepreneurship education, digital entrepreneurial intention, stimulus-organism-response, necessary condition analysis, PLS-SEM, sustainable development

Posted Date: September 14th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10632318/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Digital entrepreneurship is becoming a realistic career option in economies that are digitalizing quickly. Evidence on how digital entrepreneurship education (DEE) relates to digital entrepreneurial intention (DEI) is still modest and varies across settings. This study applies a stimulus-organism-response architecture that draws on six theoretical perspectives. DEE is treated as a human capital stimulus that is linked to DEI directly and through three internal states, namely perceived behavioral control (PBC), entrepreneurial motivation (EM) and entrepreneurial passion (EP). Team cooperation (TC) and entrepreneurial resilience (ER) are examined as boundary conditions. Survey data from 793 students at one university in Da Nang, Vietnam, were analyzed with partial least squares structural equation modeling, necessary condition analysis (NCA), measurement invariance testing and permutation-based multigroup analysis. DEE was associated with DEI directly ($\beta = 0.298$) and more strongly through the three states, and the model explained 79.4% of the variance in DEI. PBC carried the largest share of the association. NCA identified DEE as the most binding necessary condition ($d = 0.222$), while EM became necessary only at high levels of intention. In exploratory subgroup comparisons, the affective route was clearer among Economics and Management students and the feasibility route among Engineering and Technology students. ER strengthened the passion route, whereas TC showed no moderating role. Embedding discipline-tailored DEE may support intention formation in emerging digital economies.

1. Introduction

The digital economy has changed how new ventures are created and scaled. Digital platforms, data-driven business models and low-cost online tools have moved a large share of entrepreneurial opportunity into the digital space. Digital infrastructure lowers entry barriers, reduces start-up costs and widens market access, so digital venturing has become a realistic career path for graduates [1]. This shift matters most in emerging economies that are digitalizing quickly. It also connects directly to sustainable development, because inclusive digital venturing supports quality education, decent work and productive employment for young people.

Vietnam illustrates this pattern. National policy treats entrepreneurship and the digital economy as strategic priorities, most visibly through the national innovative start-up ecosystem scheme [2] and the national digital transformation program [3]. These programs treat educational provision as basic infrastructure for venture creation. Da Nang has followed an innovation-driven development strategy, which makes it a useful setting for studying how universities prepare students for digital venturing.

Digital entrepreneurship education (DEE) is the main instrument through which universities build entrepreneurial human capital for this context [4, 5]. DEE extends conventional entrepreneurship education by combining entrepreneurial knowledge, digital competence, innovative thinking and practical venture skills [6]. Its proximal target is digital entrepreneurial intention (DEI), which is a person's conscious readiness to establish a digital venture and the most immediate antecedent of entrepreneurial action [7, 8]. Evidence on the education-intention link remains modest. Meta-analytic work reports small

average associations that differ across national settings [9], and recent studies suggest that the link depends on intervening psychological factors [10]. The value of DEE is therefore unlikely to be captured by a single direct association [11, 12].

Three gaps follow. The first is theoretical. Prior work has usually examined cognitive, motivational or affective mediators in isolation, so how these mechanisms work in parallel remains unclear in the DEE context. The second gap concerns boundary conditions, which are rarely modeled even though the education-intention link is unlikely to be uniform across learning environments and personal resources. Team cooperation (TC) captures the collaborative character of entrepreneurial learning [13], while entrepreneurial resilience (ER) is a personal resource that may protect the conversion of passion into intention [14]. A related question is whether the mechanism differs by academic discipline, since business-oriented and technically oriented students appraise digital venturing differently. The third gap is methodological. The literature relies almost entirely on sufficiency-based estimators such as regression and structural equation modeling, which show how much an antecedent raises intention on average [10, 15]. These methods cannot show whether a minimum level of an antecedent must be present for intention to form, which is a different logic with different practical meaning [16].

To address these gaps, this study uses a multi-analytic design on a sample of 793 students in Da Nang. It combines partial least squares structural equation modeling (PLS-SEM), necessary condition analysis (NCA), measurement invariance testing (MICOM) and permutation-based multigroup analysis (PLS-MGA). Four research questions guide the work. First, how far is DEE associated with DEI directly and through PBC, EM and EP? Second, do TC and ER condition these associations? Third, which antecedents act as necessary conditions for DEI? Fourth, do the associations differ between Economics and Management students and Engineering and Technology students? The study contributes by decomposing the organism into three parallel mechanisms, by combining sufficiency and necessity logics, by introducing two boundary conditions and by comparing disciplinary subgroups. Because the design is cross-sectional, all relationships are read as theory-consistent associations rather than causal effects.

2. Theoretical framework and hypotheses

2.1. Theoretical foundation

The model integrates the stimulus-organism-response (S-O-R) framework [17] with the Theory of Planned Behavior (TPB; Ajzen, 1991), Social Cognitive Career Theory (SCCT; Lent et al., 1994), the Entrepreneurial Event Model (EEM; Shapero & Sokol, 1982) and Human Capital Theory (HCT, Becker, 1964). Entrepreneurial passion theory (EPT; Cardon et al., 2013) and Conservation of Resources theory (COR; Hobfoll, 1989) complete the framework. S-O-R supplies the overall ordering. TPB, SCCT, EEM and HCT define the meaning of the stimulus, the organism and the response. EPT and COR ground the affective state and the resilience-based boundary condition.

Within this ordering, DEE is the stimulus, PBC, EM and EP form the organism, and DEI is the response. HCT explains why DEE can be treated as an investment in entrepreneurial human capital, since it builds digital competence, technological awareness and opportunity recognition [11, 12]. TPB explains the inclusion of PBC, because digital venturing requires students to believe that they command the needed skills, tools and resources. The EEM adds two appraisals. Its feasibility component converges with PBC and gives the cognitive state theoretical triangulation, while its desirability component is reflected in the two remaining states. SCCT explains how learning experiences, self-efficacy beliefs and personal goals shape career intentions, which is captured by EM as goal-directed energy. EPT frames EP as affective attachment to entrepreneurial activity and identity. The organism is therefore not a single state but a set of cognitive, motivational and affective mechanisms.

2.2. Digital entrepreneurship education and digital entrepreneurial intention

Digital entrepreneurship refers to creating and running ventures in which digital technologies are central to value creation [1, 21]. DEI is the conscious readiness and commitment to establish such a venture in the future [8]. Because intention is the most proximal predictor of planned behavior [7], DEI is the dependent construct here.

Entrepreneurship education develops awareness and core competencies such as opportunity recognition, adaptability and risk-taking [6]. DEE extends this role to the digital context through structured learning that joins entrepreneurial knowledge, digital competence and practical platform skills [6, 22]. In practice, DEE covers both the digital curriculum and the digital teaching methods used to deliver it [23]. Recent evidence links entrepreneurship education and DEE to intention both directly and through self-efficacy, motivation and passion [24, 25]. DEE is therefore positioned as a stimulus associated with DEI directly and indirectly. This leads to the first hypothesis. H1 proposes that DEE is positively associated with DEI.

2.3. Digital entrepreneurship education and the three organismic states

Exposure to digital business models and venture tasks should raise students' sense of capability and control, strengthen their career-related goals and increase their attachment to entrepreneurial activity. Three hypotheses follow. H2, H3 and H4 propose that DEE is positively associated with PBC, EM and EP respectively.

Each state is then treated as an antecedent of intention. PBC reflects the belief that digital venturing is achievable, which is the core feasibility appraisal in TPB and the EEM. EM reflects goal-directed energy in the SCCT sense. EP reflects positive affect and identity attachment in the EPT sense. H5, H6 and H7 therefore propose that PBC, EM and EP are each positively associated with DEI. Because the three states stand between the stimulus and the response, H8, H9 and H10 propose that PBC, EM and EP respectively mediate the association between DEE and DEI.

2.4. Boundary conditions

Two moderators are added. TC captures the extent to which students work effectively with peers on shared entrepreneurial tasks [26]. Collaborative learning may help students convert educational provision into personal readiness, so TC is examined as an exploratory contextual moderator. H11 proposes that TC moderates the association between DEE and DEI.

ER is drawn from COR theory, which treats personal resources as assets that people use to protect valued outcomes under strain [14]. Passion is affective and may fade when students face uncertainty or setbacks. Resilience may protect the conversion of passion into intention, and recent Vietnamese evidence supports an interaction between resilience and passion in intention formation [27]. H12 proposes that ER moderates the association between EP and DEI. H13 extends this to the indirect route and proposes that ER conditions the indirect association running from DEE through EP to DEI.

2.5. Conceptual model

The full model is shown in Fig. 1. Detailed hypothesis development and supporting references are provided in **Supplementary Document S1**. A keyword co-occurrence analysis of 75 Scopus-indexed publications from 2023 to 2026, reported in **Supplementary Document S2**, supports the specification. The network centers on digital entrepreneurship and DEI, links education and self-efficacy to these central nodes, and shows weak representation of EM as a distinct mediator and of the DEE-EP link. TC and ER are largely absent from the network. Because the analysis covers author-supplied keywords only, limited representation signals an under-explored area rather than absence from the wider literature.

3. Methods

3.1. Study design, setting and ethics

This study used a cross-sectional, self-administered questionnaire survey of students at Duy Tan University, a multidisciplinary university in Da Nang, central Vietnam. The design suits the estimation of the latent constructs and moderating relationships specified in the model [28]. The participating university was selected because it hosts both disciplinary groups within one institution, which holds institutional provision constant across the comparison, and because Da Nang pursues an innovation-driven development strategy.

The study protocol was approved by the Research Ethics Committee of Duy Tan University under approval code DTU/REC2025/NHH119. All participants provided informed consent before completing the questionnaire, participation was voluntary, and responses were collected anonymously.

3.2. Participants, recruitment and sample size

Purposive non-probability sampling was used to reach students with sufficient exposure to DEE in the two target disciplinary groups, namely Economics and Management, and Engineering and Technology.

This strategy also allowed the planned multigroup comparison. Students were eligible if they were currently enrolled at Duy Tan University, a multidisciplinary university in Da Nang, central Vietnam, were at least 18 years old and agreed to take part. Students who were not currently enrolled were excluded.

Data were collected between December 2025 and April 2026. The questionnaire was administered in two formats. The online version was distributed through Google Forms and the paper version was administered directly to eligible respondents. In total, 807 questionnaires were collected.

Sample size adequacy was assessed with the inverse square root method [29]. With a smallest expected path coefficient of 0.20, the method indicated a minimum of 155 cases. The retained sample of 793 valid responses far exceeds this minimum, with post hoc power of 1.0 for the main paths but substantially lower power for the small interaction coefficients.

3.3. Measures and questionnaire development

The questionnaire contained 38 substantive items covering the seven study constructs, together with demographic questions on gender, field of study, family business background and average monthly family income. All items were adapted from validated scales. DEE was measured with 9 items from Wibowo et al. [30], which cover both digital teaching curricula and digital teaching methods. PBC was measured with 5 items from Kolvereid [31] and Autio et al. [32]. EM was measured with 5 items from Solesvik [33]. EP was measured with 4 items from Cardon et al. [34]. ER was measured with 4 items from Sinclair and Wallston [35]. TC was measured with 3 items from Shen and Benson [36]. DEI was measured with 8 items from Liñán [37] and Vejayaratnam et al. [38]. All items used a five-point Likert format from 1, strongly disagree, to 5, strongly agree. Full item wording and sources are reported in **Supplementary Table S1**.

The items were translated into Vietnamese and independently back-translated into English following the procedure of Brislin [39]. Differences between versions were resolved by an expert panel before pretesting. The draft instrument was then reviewed through expert consultation and group discussion with specialists in entrepreneurship and DEE. A pilot test with 30 students checked item clarity, after which minor wording changes were made. The conceptual model was not changed.

3.4. Data screening and bias assessment

Returned questionnaires were screened in three steps. Cases with missing responses were removed first. Cases with invariant answering, such as straight-lining across an entire scale, were removed next. Remaining invalid response patterns were then removed. This screening excluded 14 of the 807 collected questionnaires and retained 793 valid responses. Item-level means, medians, standard deviations, skewness and excess kurtosis were inspected and are reported in **Supplementary Table S2**. Mardia's multivariate skewness and kurtosis tests indicated departures from multivariate normality ($p < .001$), which supports the use of PLS-SEM because this estimator does not assume normally distributed data [28].

Common method variance (CMV) was addressed in two ways. Procedurally, respondents were assured of anonymity and confidentiality, and item wording was kept short and concrete. Statistically, the full collinearity approach of Kock [40] was applied by regressing all constructs on a random dependent variable and inspecting the resulting variance inflation factors (VIF), with 3.3 as the conservative benchmark and 5.0 as the more permissive one [28, 41]. No marker variable was administered, because adding unrelated items risked respondent fatigue. The diagnostic is therefore interpreted as indicative rather than conclusive.

3.5. Analytical strategy

All models were estimated in SmartPLS 4.1.0.9. The analysis followed six stages.

The first stage assessed the reflective measurement model. Indicator reliability was judged by outer loadings, with 0.70 as the reference value. Indicators below this value were considered for removal when their retention weakened construct reliability, convergent validity or discriminant validity, and indicators between 0.40 and 0.70 could be retained when the construct still met the reliability and validity requirements [28]. Internal consistency was assessed with Cronbach's alpha and composite reliability, using 0.70 as the reference value. Convergent validity was assessed with the average variance extracted (AVE), using 0.50 as the reference value Fornell & Larcker [42]. Discriminant validity was assessed with the Fornell-Larcker criterion and with the heterotrait-monotrait ratio of correlations (HTMT). HTMT was treated as the primary criterion because it is more sensitive in variance-based modeling, with 0.90 as the benchmark for conceptually related constructs and 0.95 as the upper benchmark for conceptually similar constructs [43]. HTMT was also tested through bootstrap confidence intervals with 5,000 subsamples, where an interval excluding 1.00 supports discriminant validity. Approximate model fit was assessed with SRMR, d_ULS, d_G, chi-square and NFI for the total sample and both subgroups, using 0.08 as the reference value for SRMR.

Because the planned multigroup comparison requires an identical indicator set across groups, the measurement model was refined on the pooled sample and the resulting indicator set was held constant when the two subgroups were estimated. Removing indicators separately in each group would have broken the configural and compositional invariance needed for a valid comparison.

The second stage assessed the structural model. Inner-model VIF values were inspected first, using 5.0 as the reference value. Path coefficients were then estimated and tested with bootstrapping using 5,000 subsamples. Explanatory power was judged by R^2 and adjusted R^2. Predictive relevance was judged by Q^2predict, and out-of-sample predictive power was judged with the PLSpredict procedure, in which indicator-level root mean square error (RMSE) values from PLS-SEM are compared with those from a naïve linear model benchmark [44]. Specific indirect associations for the three mediated routes were estimated with bootstrapped confidence intervals, and the share of the total association carried by the mediators was expressed as the variance accounted for (VAF).

The fifth stage compared the two disciplinary subgroups. Measurement invariance was assessed first with the MICOM procedure, which proceeds from configural invariance to compositional invariance and

then to equality of composite means and variances [45]. Partial invariance, meaning configural and compositional invariance, is sufficient for comparing standardized path coefficients [46]. A permutation-based PLS-MGA with 5,000 permutations then compared all eleven structural paths, including the two interaction terms, using two-tailed tests.

The sixth stage applied NCA to test necessity. Whereas PLS-SEM identifies factors that raise DEI on average, NCA tests whether a minimum level of a condition must be present for a given level of DEI to be possible. The CE-FDH ceiling line was used because it suits discrete five-point Likert data, effect sizes were tested with an approximate permutation test using 5,000 resamples, and a condition was treated as meaningful only when $d \geq 0.10$ and $p < .05$ [16, 47]. The bottleneck technique then identified the level of each condition required to reach successive levels of DEI. Because the design is cross-sectional, all coefficients are interpreted as standardized associations.

4. Results

4.1. Sample profile

The final sample comprised 793 respondents. Economics and Management students accounted for 51.10% (n = 405) and Engineering and Technology students for 48.90% (n = 388). Female respondents accounted for 62.40% (n = 495) and male respondents for 37.60% (n = 298). Almost half of the sample reported a family business background (47.92%, n = 380). Average monthly family income was below 15 million VND for 32.00% of respondents, between 15 and 20 million VND for 36.70%, between 20 and 30 million VND for 16.30% and above 30 million VND for 15.00%. Full demographic characteristics are reported in **Supplementary Table S3**.

4.2. Common method variance

Full collinearity VIF values ranged from 1.006 to 4.794 (**Supplementary Table S4**). Four constructs exceeded the conservative benchmark of 3.3, namely DEI (4.794), DEE (4.724), PBC (3.993) and EM (3.558). All values remained below 5.0, and the elevated values were concentrated among the four conceptually closest constructs.

4.3. Measurement model

Six indicators showed weak initial loadings and were removed, namely DEI1 ($\lambda = 0.185$), PBC3 ($\lambda = 0.270$), DEI8 ($\lambda = 0.510$), EM1 ($\lambda = 0.548$), TC3 ($\lambda = 0.565$) and DEE5 ($\lambda = 0.601$). DEE1 was also removed during refinement. Its initial loading was acceptable ($\lambda = 0.742$), but its retention weakened discriminant validity in the HTMT assessment involving DEE and adjacent constructs. Thirty-one indicators were retained (**Supplementary Tables S5 and S6**).

In the refined model, outer loadings ranged from 0.739 to 0.952 in the total sample and outer VIF values ranged from 1.335 to 3.387 (Table 1). Four indicators loaded below 0.70 within individual subgroups, namely ER1 and TC2 in the Engineering and Technology subgroup, both at 0.600, and ER3 ($\lambda = 0.690$) and

ER4 (λ = 0.662) in the Economics and Management subgroup. Reliability and convergent validity remained acceptable for these constructs in both subgroups, with CR = 0.879 and AVE ≥ 0.650 for ER, and CR ≥ 0.788 and AVE ≥ 0.665 for TC. The weighting of the ER indicators differed markedly across subgroups, since ER1 loaded at 0.912 among Economics and Management students and at 0.600 among Engineering and Technology students.

Table 1
Assessment criteria and results for construct reliability, convergent validity and discriminant validity.

Assessment measure	Criterion	Threshold	Total Sample	Economics and Management	Engineering and Technology
Indicator Reliability	Outer loadings	> 0.70	0.739–0.952	0.662–0.948	0.600–0.996
Multicollinearity	Variance inflation	< 5.00	1.335–3.387	1.297–4.527	1.342–2.972
Cronbach's Alpha	Internal consistency	> 0.70	0.659–0.941	0.647–0.954	0.671–0.919
Composite Reliability	Internal consistency	> 0.70	0.850–0.953	0.834–0.963	0.788–0.937
Average Variance extracted	Convergent validity	> 0.50	0.693–0.807	0.650–0.836	0.645–0.774
Heterotrait-Monotrait ratio	Discriminant validity	< 0.90 (0.95 for conceptually similar constructs)	0.034–0.909	–	–
Fornell–Larcker Criterion	Discriminant validity	√AVE > r	Supported (except DEE–DEI: r = 0.839 vs √AVE = 0.834)	–	–

Note. AVE, average variance extracted. VIF, variance inflation factor. r, inter-construct correlation. Thresholds follow Fornell and Larcker (1981), Hair et al. (2021) and Henseler et al. (2015). One HTMT value exceeded 0.90 (DEE–EM = 0.909), below the 0.95 benchmark for conceptually similar constructs; all bootstrap intervals excluded 1.00. Values close to 0.70 for Cronbach's alpha may be acceptable for short scales when composite reliability and AVE are satisfactory. Team cooperation returned alpha = 0.659, CR = 0.850 and AVE = 0.739.

Cronbach's alpha ranged from 0.659 to 0.941 and composite reliability ranged from 0.850 to 0.953 (**Supplementary Table S7**). Alpha for TC fell slightly below 0.70 at 0.659, while its composite reliability reached 0.850 and its AVE reached 0.739. AVE values ranged from 0.693 to 0.807 across constructs.

Under the Fornell-Larcker criterion, the condition was met for every construct except the DEE-DEI pair, where the correlation of 0.839 marginally exceeded the square root of the AVE of DEE at 0.834, a difference of 0.005 (**Supplementary Table S8**). HTMT values ranged from 0.034 to 0.909. Twenty of the twenty-one construct pairs fell at or below 0.90. One pair, DEE-EM, reached 0.909. The bootstrap confidence intervals excluded 1.00 for every pair, including DEE-DEI at 0.898, 95% CI [0.864, 0.926], and DEE-EM at 0.909, 95% CI [0.873, 0.939] (**Supplementary Table S9**).

Approximate fit results are reported in Table 2. SRMR values ranged from 0.036 to 0.058 across the saturated and estimated models in all three samples. NFI reached 0.910 for the saturated model and 0.904 for the estimated model in the total sample. NFI values were lower in the subgroups, at 0.889 and 0.880 for Economics and Management and at 0.859 and 0.854 for Engineering and Technology.

Table 2
Approximate model fit for the total sample and the two subgroups.

	Total Sample		**Economics and Management**		**Engineering and Technology**	
	Saturated model	**Estimated model**	**Saturated model**	**Estimated model**	**Saturated model**	**Estimated model**
SRMR	0.036	0.051	0.039	0.057	0.049	0.058
d_ULS	0.626	1.267	0.773	1.62	1.18	1.665
d_G	0.387	0.43	0.575	0.661	0.545	0.579
Chi-square	1,792.349	1,910.166	1,336.899	1,443.883	1,194.344	1,237.599
NFI	0.91	0.904	0.889	0.88	0.859	0.854

Note. SRMR, standardized root mean square residual. d_ULS, squared Euclidean distance. d_G, geodesic distance. NFI, normed fit index. The saturated model uses unconstrained correlations and the estimated model is the hypothesized structural model.

4.4. Structural model: direct and indirect associations

Inner-model VIF values were all below 5.0 (**Supplementary Table S10**).

All seven direct paths were positive and significant in the total sample (Table 3). DEE was associated with DEI (β = 0.298, t = 6.502, H1), with PBC (β = 0.815, t = 40.561, H2), with EM (β = 0.829, t = 42.577, H3) and with EP (β = 0.719, t = 24.434, H4). PBC (β = 0.308, t = 6.789, H5), EM (β = 0.219, t = 5.034, H6) and EP (β = 0.140, t = 4.046, H7) were each associated with DEI. H1 to H7 were supported in the total sample.

Table 3
Direct paths (H1 to H7) and specific indirect paths (H8 to H10) for the total sample and the two subgroups.

Paths	Total Sample			Economics and Management			Engineering and Technology		
	Original sample (O)	t-values	p values	Original sample (O)	t-values	p values	Original sample (O)	t-values	p values
H1: DEE -> DEI	0.298	6.502	p < .001	0.269	4.945	p < .001	0.317	4.489	p < .001
H2: DEE -> PBC	0.815	40.561	p < .001	0.825	31.545	p < .001	0.799	25.570	p < .001
H3: DEE -> EM	0.829	42.577	p < .001	0.847	34.251	p < .001	0.801	24.179	p < .001
H4: DEE -> EP	0.719	24.434	p < .001	0.769	20.933	p < .001	0.652	13.348	p < .001
H5: PBC -> DEI	0.308	6.789	p < .001	0.220	3.188	0.001	0.373	6.294	p < .001
H6: EM -> DEI	0.219	5.034	p < .001	0.258	4.263	p < .001	0.182	2.931	0.003
H7: EP -> DEI	0.140	4.046	p < .001	0.224	3.695	p < .001	0.083	1.940	0.050
H8: DEE -> PBC -> DEI	0.253	7.026	p < .001	0.181	3.208	0.001	0.298	6.501	p < .001
H9: DEE -> EM -> DEI	0.182	4.933	p < .001	0.218	4.204	p < .001	0.146	2.854	0.004
H10: DEE -> EP -> DEI	0.100	3.899	p < .001	0.172	3.511	p < .001	0.054	1.929	0.054

Note. β, standardized path coefficient from the original sample. Given the cross-sectional design, coefficients represent associations rather than causal effects.

All seven paths were also positive and significant among Economics and Management students, so H1 to H7 were supported in that subgroup. Among Engineering and Technology students, H1 to H6 were supported, while the EP → DEI association lay at the borderline of conventional significance (β = 0.083, t = 1.940, p = .050), so H7 was not supported there. The PBC → DEI association was larger among Engineering and Technology students (β = 0.373) than among Economics and Management students (β = 0.220). The EP → DEI association showed the opposite pattern (β = 0.224 versus β = 0.083).

The three specific indirect associations were significant in the total sample, via PBC (β = 0.253, t = 7.026, H8), via EM (β = 0.182, t = 4.933, H9) and via EP (β = 0.100, t = 3.899, H10). H8 to H10 were supported. The same pattern held among Economics and Management students (H8: β = 0.181, H9: β = 0.218, H10: β = 0.172, all p ≤ .001). Among Engineering and Technology students, the routes via PBC (β = 0.298, t = 6.501) and via EM (β = 0.146, t = 2.854) were significant, while the route via EP was not (β = 0.054, t = 1.929, p = .054).

The total indirect association of DEE with DEI was positive and significant in the total sample (β = 0.533, t = 13.066, p < .001) and in both subgroups (Economics and Management β = 0.572, Engineering and Technology β = 0.498, both p < .001) (Table 4). Alongside the significant direct path, this pattern corresponds to complementary partial mediation. Expressed as the variance accounted for, the indirect component carried 64.1% of the total association in the total sample, 68.0% among Economics and Management students and 61.1% among Engineering and Technology students.

Table 4
Total indirect association of digital entrepreneurship education with digital entrepreneurial intention.

Paths	Total Sample			Economics and Management			Engineering and Technology		
	Original sample (O)	t-values	p values	Original sample (O)	t-values	p values	Original sample (O)	t-values	p values
DEE -> DEI	0.533	13.066	p < .001	0.572	11.652	p < .001	0.498	7.789	p < .001

Note. The total indirect association aggregates the mediated routes via PBC, EM and EP.

4.5. Explanatory and predictive power

The model accounted for 79.4% of the variance in DEI, with an adjusted R^2 of 0.792 (Table 5). Explained variance reached 0.688 for EM, 0.664 for PBC and 0.517 for EP. R^2 and adjusted R^2 values were nearly identical across the four endogenous constructs.

Table 5
Explanatory and predictive power of the structural model.

DEI	Q^2predict	RMSE	MAE	R^2	Adjusted R^2
	0.702	**0.549**	**0.402**	**0.794**	**0.792**
EM	0.685	0.562	0.400	0.688	0.687
EP	0.515	0.699	0.515	0.517	0.516
PBC	0.661	0.582	0.434	0.664	0.663

Note. Q^2predict values above zero indicate predictive relevance. RMSE and MAE measure prediction error, with lower values indicating smaller error.

All Q^2predict values were above zero, at 0.702 for DEI, 0.685 for EM, 0.661 for PBC and 0.515 for EP. At the indicator level, all Q^2predict values were positive and most PLS-SEM RMSE values fell below the linear model benchmark (**Supplementary Table S11**). Three indicators, DEI3, EP1 and PBC5, showed PLS-SEM errors marginally above that benchmark, which corresponds to a medium level of out-of-sample predictive power. All PLS-SEM errors remained below the indicator-average benchmark.

4.6. Moderation and moderated mediation

The interaction between TC and DEE was not significant in the total sample (β = 0.006, t = 0.428, p = .668), among Economics and Management students (β = 0.011, t = 0.594, p = .553) or among Engineering and Technology students (β = 0.013, t = 0.372, p = .710) (Table 6). H11 was not supported in any group.

Table 6
Moderating effects (H11 and H12) for the total sample and the two subgroups.

Paths	Total Sample			Economics and Management			Engineering and Technology		
	Original sample (O)	t-values	p values	Original sample (O)	t-values	p values	Original sample (O)	t-values	p values
H11: TC x DEE -> DEI	0.006	0.428	0.668	0.011	0.594	0.553	0.013	0.372	0.710
H12: ER x EP-> DEI	0.055	2.451	0.014	0.078	2.524	0.012	0.041	1.189	0.234

Note. β, interaction-term coefficient. TC, team cooperation. ER, entrepreneurial resilience.

The interaction between ER and EP was positive and significant in the total sample (β = 0.055, t = 2.451, p = .014) and among Economics and Management students (β = 0.078, t = 2.524, p = .012). It was not

significant among Engineering and Technology students (β = 0.041, t = 1.189, p = .234). H12 was therefore supported in the total sample and in the Economics and Management subgroup only.

In the focused second-stage model, the ER × EP interaction was positive and significant in the total sample (β = 0.092, t = 4.481, 95% BCa CI [0.052, 0.132]). The passion-mediated indirect association rose with resilience, from 0.153 (t = 5.142) at minus one standard deviation, to 0.219 (t = 7.684) at the mean, to 0.283 (t = 8.402) at plus one standard deviation, all at p < .001 (Table 7). H13 was supported in the total sample. The pattern was most pronounced among Economics and Management students, where the interaction reached β = 0.109, 95% BCa CI [0.054, 0.162], and the conditional indirect association rose from 0.232 to 0.316 to 0.400 across the same three levels. Among Engineering and Technology students the interaction was smaller but significant in this focused model (β = 0.073, t = 2.268, p = .023, 95% BCa CI [0.012, 0.138]), with conditional indirect associations of 0.092 (p = .009), 0.139 and 0.187. The same interaction was not significant in the full structural model for this subgroup, so the result is reported as tentative. Full bootstrap output appears in **Supplementary Table S12**. Across the full set of hypotheses, H1 to H10, H12 and H13 were supported in the total sample; H11 was not supported in any group. Among Engineering and Technology students, the EP route and the ER × EP interaction were the two exceptions.

Table 7
Conditional indirect association of digital entrepreneurship education with digital entrepreneurial intention via entrepreneurial passion at three levels of entrepreneurial resilience (H13).

Sample	Level of ER	β	SD	t	p values	Result
Total sample	+ 1 SD	0.283	0.034	8.402	p < .001	Supported
	Mean	0.219	0.028	7.684	p < .001	
	−1 SD	0.153	0.030	5.142	p < .001	
Economics and Management	+ 1 SD	0.400	0.051	7.843	p < .001	Supported
	Mean	0.316	0.047	6.749	p < .001	
	−1 SD	0.232	0.051	4.544	p < .001	
Engineering and Technology	+ 1 SD	0.187	0.041	4.545	p < .001	Supported, tentative
	Mean	0.139	0.032	4.339	p < .001	
	−1 SD	0.092	0.035	2.630	0.009	

Note. Estimates derive from the focused second-stage moderated mediation model described in Section 3.5 *and are not directly comparable with the full-model estimates in* Table 3. *The Engineering and Technology result is tentative because the same interaction was not significant in the full structural model.*

4.7. Measurement invariance and multigroup comparison

Configural invariance was established by design (**Supplementary Table S13**). Compositional invariance was supported for all seven constructs. The composite correlation equalled 1.000 for DEE, DEI, EM, EP and PBC, while TC returned 0.630 and ER returned 0.876. Equality of composite means and variances held only for ER and TC. Partial measurement invariance was therefore established, which satisfies the precondition for comparing standardized path coefficients across the two subgroups.

The permutation-based PLS-MGA compared all eleven paths (Table 8). Only two differed significantly, and both lay on the passion route. These were DEE → EP (Δ = 0.117, p = .049) and EP → DEI (Δ = 0.141, p = .030), each stronger among Economics and Management students. The PBC → DEI difference was not significant (Δ = −0.153, p = .081), and neither was the resilience-based interaction (Δ = 0.041, p = .318). With eleven simultaneous comparisons, neither significant difference would survive a Bonferroni correction at α = .0045.

Table 8
Permutation-based multigroup analysis comparing Economics and Management with Engineering and Technology.

Paths relationship	Difference (ECO - ENG)	1-tailed (ECO vs ENG) p value	2-tailed (ECO vs ENG) p value
DEE -> DEI	-0.048	0.705	0.590
DEE -> EM	0.046	0.102	0.204
DEE -> EP	0.117	0.024	0.049
DEE -> PBC	0.026	0.265	0.530
EM -> DEI	0.076	0.144	0.288
EP -> DEI	0.141	0.015	0.030
ER -> DEI	-0.010	0.575	0.850
PBC -> DEI	−0.153	0.959	0.081
TC -> DEI	0.016	0.383	0.766
ER x EP -> DEI	0.041	0.159	0.318
TC x DEE -> DEI	−0.015	0.718	0.564

Note. Based on 5,000 permutations. A two-tailed p value below .05 indicates a significant between-group difference. Interaction-term differences derive from the permutation procedure, where product indicators are standardized on the pooled sample; they therefore differ from the arithmetic difference of the coefficients in Table 6.

4.8. Necessary condition analysis

All four conditions met both NCA criteria (Table 9). DEE produced the largest effect size (d = 0.222), followed by EM (d = 0.141), PBC (d = 0.131) and EP (d = 0.112), all at p < .001. All four fell within the

medium effect-size band. The empty space above the ceiling line was most pronounced for DEE and clearly visible for the other three conditions (**Supplementary Figure S1**).

Table 9
Necessary condition analysis based on the CE-FDH ceiling line.

Construct	Effect size (d)	p-value	Accuracy	Condition inefficiency (%)	Outcome inefficiency (%)	Rel. inefficiency	Abs. inefficiency
DEE	0.222	p < .001	100.000	52.886	0.000	52.886	12.721
EM	0.141	p < .001	100.000	62.556	58.177	84.340	19.758
EP	0.112	p < .001	100.000	69.058	20.901	75.525	16.706
PBC	0.131	p < .001	100.000	50.000	20.901	60.451	13.836

Note. Effect size bands follow Dul (2016), where values from 0.10 to below 0.30 are medium. CE-FDH, ceiling envelopment with free disposal hull. Condition inefficiency is the share of the condition range that does not constrain the outcome. Outcome inefficiency is the share of the outcome range that is not constrained by the condition.

The bottleneck analysis showed where each condition becomes binding (**Supplementary Table S14**). DEE became necessary from the 10% level of the maximum DEI onward, and its required level rose steadily as the target level of DEI increased. PBC and EP became necessary from the 30% level. EM became binding only from the 60% level and was recorded as not necessary below that point.

5. Discussion

5.1. Main findings

The results support the S-O-R ordering as a coherent pattern of associations. DEE was associated with DEI directly and through three internal states, and the model explained a large share of the variance in intention with medium out-of-sample predictive power. These associations are stronger than the small, context-dependent education-intention relationships reported in meta-analytic work [9]. Two features plausibly explain the difference. The first is the digital, human-capital-intensive form of education studied here. The second is the mediated structure of the model, in which most of the association travels through psychological states rather than appearing as a single direct effect.

The cognitive route was the most prominent. PBC carried the largest association with intention, ahead of motivation and passion. This accords with digital entrepreneurship research reporting that intention depends heavily on students' appraisal of their digital readiness and capability [11, 12] and with Vietnamese evidence linking education to intention through self-efficacy and learning orientation [48]. It

contrasts with the affect-centered strand in which passion is a salient mediator. One plausible reading is that students first judge digital venturing as a question of capability and only then as a question of passion. National policy is expanding digital opportunity quickly, yet the gating consideration for many students may remain whether they personally command the required skills.

The indirect component carried roughly two thirds of the total association, which fits the human capital premise that educational investment builds the capabilities underlying entrepreneurial orientation [4]. A meaningful direct association nonetheless remained unmediated, so the three modeled states do not exhaust the mechanisms at work. Entrepreneurial alertness, mindset and self-efficacy are plausible further candidates [49, 50].

Motivation illustrates the value of combining the two analytic logics. It functioned as a distinct and significant mediator, yet the necessity analysis showed that it binds only from the 60% level of intention upward. Motivation therefore raises intention on average and is required for high intention, while moderate intention can form without it. DEE behaved differently. It was both the strongest correlate and the most binding necessary condition, becoming necessary from the lowest intention level. A baseline of educational provision appears to accompany the emergence of intention in a way that motivational or affective strengths cannot compensate for.

The overall strength and mediated character of the relationship were similar across fields, but the operative mechanism differed. The passion route was stronger among Economics and Management students, while the feasibility route was more prominent among Engineering and Technology students. Only two of eleven compared paths differed significantly, and neither would survive correction for multiple testing, so these contrasts are exploratory. They are intelligible in a curriculum landscape where technical programs foreground skill and feasibility while business programs foreground venture creation and entrepreneurial identity. Self-selection into each field may also contribute.

The two boundary conditions produced asymmetric results. Resilience strengthened the passion route in the total sample and among Economics and Management students, which is consistent with COR theory and with recent Vietnamese evidence [27, 51]. The multigroup test found no significant cross-group difference on this interaction, so the resilience mechanism is best described as evidenced overall rather than as discipline dependent. TC did not moderate the education-intention association in any group. Two context-specific readings are plausible. Cooperative learning is a pervasive norm in Vietnamese higher education, so it may vary little across students and leave little room to differentiate the relationship [52]. Cooperation may also become consequential later, when a venture team is actually assembled, rather than when intention forms. Measurement bounds this reading further, since TC was retained with two items at the lower bound of reliability.

5.2. Theoretical implications

Four implications follow. First, the S-O-R framework works well as an integrative architecture for DEE when the organism is decomposed into parallel cognitive, motivational and affective states rather than a single mediator. Second, the dominance of PBC refines the application of TPB and the EEM to the digital

context by identifying feasibility cognition as the principal conduit. Third, combining sufficiency and necessity logics advances theory on the difference between average antecedents and prerequisites. Theories of entrepreneurial intention should distinguish not only which factors raise intention but also where along the outcome range each prerequisite becomes binding. Fourth, the moderation results support boundary-conditioned theorizing. Resilience extends COR theory as a second-stage personal resource, while the null role of TC shows that a culturally pervasive contextual factor need not act as a boundary condition.

5.3. Practical implications

The necessity result suggests treating DEE as foundational rather than elective provision, which fits national digital-economy and start-up ecosystem agendas and supports wider goals on quality education and decent work. Because PBC was the dominant correlate, programs are likely to work best when they build feasibility through hands-on digital skills, exposure to real digital business models and mentoring.

The disciplinary contrast argues against a uniform curriculum. Economics and Management students may benefit from activities that cultivate passion, entrepreneurial identity and resilience. Engineering and Technology students may benefit from support that converts technical competence into venture-relevant readiness. Failure-tolerant projects and mentorship may help sustain passion under uncertainty. Because motivation was widespread but not the binding constraint, motivational messaging alone is insufficient and should accompany capability development. The null role of TC suggests placing genuine entrepreneurial collaboration closer to venture-team formation, supported by closer links between universities and local incubators.

5.4. Limitations and future research

Several limitations qualify these contributions. The cross-sectional, single-source design prevents causal inference, so longitudinal and experimental work is needed to test the directional logic of the framework. Reciprocal or selection processes cannot be excluded, since students already oriented toward digital venturing may seek more educational exposure. Intention also remains an imperfect proxy for later behavior [53]. The purposive, single-institution sample limits generalizability. Because all respondents came from one university, the findings reflect one curricular and pedagogical environment, and institution-level variation in DEE provision could not be examined; multi-institution probability sampling is needed. Because all responses were collected between December 2025 and April 2026, the findings describe one moment in Vietnam’s digital-economy trajectory.

Four measurement issues warrant attention. DEE and DEI were empirically close, so future work could separate them through temporally separated or objective measures of educational exposure. ER was the least comparable construct across subgroups and needs a more invariant scale. TC was retained with two items at the lower bound of reliability and returned the lowest composite correlation in the invariance assessment, so inferences involving this construct should be read with caution. This does not affect the substantive conclusions, because the TC moderation was non-significant in every group. DEE was modeled unidimenionally and could be specified as a higher-order construct in future work. Finally,

residual common method variance cannot be excluded, the multigroup analysis tested eleven paths, and neither significant difference would survive a Bonferroni correction.

6. Conclusions

This study examined how DEE relates to DEI among 793 students at one university in Da Nang, Vietnam, using an integrated S-O-R framework and a combination of PLS-SEM, NCA, measurement invariance testing and permutation-based multigroup analysis. DEE was positively associated with DEI directly and, more substantially, through PBC, EM and EP, with feasibility cognition as the dominant conduit. DEE was both the strongest correlate and the most binding necessary condition for intention, while motivation became a prerequisite only at high levels of intention. The operative mechanism appeared to differ by discipline, tentatively following an affective route among Economics and Management students and a feasibility route among Engineering and Technology students. Resilience conditioned the passion route overall, while TC did not moderate the relationship in any group. The findings suggest that treating DEE as foundational provision and tailoring pedagogy by discipline may support intention formation within a developing digital economy. Because the evidence is cross-sectional and associational, these conclusions await confirmation in longitudinal and experimental research.

Declarations

Acknowledgements

Not applicable.

Declarations

Ethical approval

Ethics approval for this study was obtained from the Research Ethics Committee of Duy Tan University (No. DTU/REC2025/NHH119). The study was conducted in accordance with the Belmont Report (1979).

Consent to participate

All participants were adults and provided written informed consent before completing the survey.

Consent to publish

Not applicable.

Competing interests

All authors declare that they have no competing interests.

Funding

This research received no external funding.

Clinical trial number

Not applicable.

Data availability statement

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Author contributions statement

D.T.T. contributed substantially to the conception and design of the study, development of the research framework, data analysis, interpretation of the findings, and drafting of the manuscript. D.T.T. led the data collection, literature review, and initial manuscript preparation. N.T.T.H. supervised the study, provided methodological guidance, critically revised the manuscript, and coordinated its finalisation. N.T.A., N.T.H.O, T.T.D., D.T.D., N.H.V.T, and H.T.D.L contributed to data collection, questionnaire preparation, literature review, data checking, and manuscript revision. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

References

1. Paul J, Alhassan I, Binsaif N, Singh P. Digital entrepreneurship research: A systematic review. J Bus Res Elsevier. 2023;156:113507. https://doi.org/10.1016/j.jbusres.2022.113507.
2. Project 844; Decision No. 844/QĐ-TTg. Decision No. 844/QĐ-TTg [Internet]. 2016 [cited 2026 June 18]. http://vanban.chinhphu.vn/default.aspx?pageid=27160&docid=184702. Accessed 18 June 2026.
3. Decision No. 749/QĐ-TTg. Phê duyệt Chương trình Chuyển đổi số quốc gia đến năm 2025, định hướng đến năm 2030 [Approving the National Digital Transformation Program to 2025, with orientations toward 2030]. Hà Nội: Prime Minister of Vietnam; 2020 June.
4. Becker GS. Human capital. The concise encyclopedia of economics. Volume 2. Indiana: Liberty Fund, Inc; 1964. pp. 1–12.
5. Ratten V, Usmanij P. Entrepreneurship education: Time for a change in research direction? Int J Manage Educ Elsevier. 2021;19:100367. https://doi.org/10.1016/j.ijme.2020.100367.
6. Liang Y, Chen R, Hong H, Li S, Han L. Shaping digital entrepreneurial intention in higher education: the role of entrepreneurship education, creativity, and digital literacy among Chinese university students. J Innov Knowl Elsevier. 2025;10:100788. https://doi.org/10.1016/j.jik.2025.100788.
7. Ajzen I. The theory of planned behavior. Organizational Behavior and Human Decision Processes. Organizational behavior and human decision processes. Elsevier. 1991;50:179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

8. Allen SJ. On the Cutting Edge or the Chopping Block? Fostering a Digital Mindset and Tech Literacy in Business Management Education. J Manage Educ. 2020;44:362–93. https://doi.org/10.1177/1052562920903077.
9. Zhang W, Li Y, Zeng Q, Zhang M, Lu X. Relationship between entrepreneurship education and entrepreneurial intention among college students: A meta-analysis. Int J Environ Res public health MDPI. 2022;19:12158. https://doi.org/10.3390/ijerph191912158.
10. Sun J, Shi J, Zhang J. From entrepreneurship education to entrepreneurial intention: Mindset, motivation, and prior exposure. Front Psychol Front Media SA. 2023;14:954118. https://doi.org/10.3389/fpsyg.2023.954118.
11. Bachmann N, Rose R, Maul V, Hölzle K. What makes for future entrepreneurs? The role of digital competencies for entrepreneurial intention. J Bus Res. 2024;174. https://doi.org/10.1016/j.jbusres.2023.114481.
12. Nguyen TT, Dao TT, Tran TB, Nguyen HTT, Le LTN, Pham NTT. Fintech literacy and digital entrepreneurial intention: Mediator and Moderator Effect. Int J Inform Manage Data Insights Elsevier. 2024;4:100222. https://doi.org/10.1016/j.jjimei.2024.100222.
13. Li L, Wu D. Entrepreneurial education and students' entrepreneurial intention: does team cooperation matter? J Glob Entrepr Res. 2019;9:35. https://doi.org/10.1186/s40497-019-0157-3.
14. Hobfoll SE. Conservation of resources: a new attempt at conceptualizing stress. American psychologist. Am Psychol Association. 1989;44:513–24. https://doi.org/10.1037/0003-066X.44.3.513.
15. Martínez-Gregorio S, Badenes-Ribera L, Oliver A. Effect of entrepreneurship education on entrepreneurship intention and related outcomes in educational contexts: A meta-analysis. Int J Manage Educ Elsevier. 2021;19:100545. https://doi.org/10.1016/j.ijme.2021.100545.
16. Dul J. Identifying single necessary conditions with NCA and fsQCA. J Bus Res. 2016;69:1516–23. https://doi.org/10.1016/j.jbusres.2015.10.134.
17. Mehrabian A, Russell JA. An approach to environmental psychology. the MIT; 1974.
18. Lent RW, Brown SD, Hackett G. Toward a unifying social cognitive theory of career and academic interest, choice, and performance. J Vocat Behav Elsevier. 1994;45:79–122. https://doi.org/10.1006/jvbe.1994.1027.
19. Shapero A, Sokol L. The social dimensions of entrepreneurship. University of Illinois Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship; 1982.
20. Cardon MS, Grégoire DA, Stevens CE, Patel PC. Measuring entrepreneurial passion: Conceptual foundations and scale validation. J Bus venturing Elsevier. 2013;28:373–96. https://doi.org/10.1016/j.jbusvent.2012.03.003.
21. Sahut J-M, Iandoli L, Teulon F. The age of digital entrepreneurship. Small Bus Econ. 2021;56:1159–69. https://doi.org/10.1007/s11187-019-00260-8.
22. Karyaningsih RPD, Wibowo A, Saptono A, Narmaditya BS. Does entrepreneurial knowledge influence vocational students' intention? Lessons from Indonesia. Entrepreneurial Bus Econ Rev Uniwersytet

Ekonomiczny w Krakowie. 2020;8:138–55. https://doi.org/10.15678/EBER.2020.08040.

23. Wibowo A, Narmaditya BS, Sebayang KDA, Mukhtar S, Shafiai MHM. How does digital entrepreneurship education promote entrepreneurial intention? The role of social media and entrepreneurial intuition. Social Sci Humanit Open Elsevier. 2023;8:100681. https://doi.org/10.1016/j.ssaho.2023.100681.
24. Alzahrani S, Bhunia AK. A serial mediation model of the relationship between digital entrepreneurial education, alertness, motivation, and intentions. Sustain MDPI. 2024;16:8858. https://doi.org/10.3390/su16208858.
25. Anwar I, Ahmad A, Saleem I, Yasin N. Role of entrepreneurship education, passion and motivation in augmenting Omani students' entrepreneurial intention: A stimulus-organism-response approach. Int J Manage Educ Elsevier. 2023;21:100842. https://doi.org/10.1016/j.ijme.2023.100842.
26. Li L, Wu D. Entrepreneurial education and students' entrepreneurial intention: does team cooperation matter? J Glob Entrepr Res. 2019;9:35. https://doi.org/10.1186/s40497-019-0157-3.
27. Hoang G, Luu TT. The curvilinear effect of entrepreneurship education on entrepreneurial intentions: The roles of entrepreneurial passion and resilience. J Manage Educ. 2025;49:9–44. https://doi.org/10.1177/10525629241263801.
28. Hair JF, Astrachan CB, Moisescu OI, Radomir L, Sarstedt M, Vaithilingam S, et al. Executing and interpreting applications of PLS-SEM: Updates for family business researchers. J Family Bus Strategy Elsevier. 2021;12:100392. https://doi.org/10.1016/j.jfbs.2020.100392.
29. Kock N, Hadaya P. Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. Inform Syst J. 2018;28:227–61. https://doi.org/10.1111/isj.12131.
30. Wibowo A, Narmaditya BS, Sebayang KDA, Mukhtar S, Shafiai MHM. How does digital entrepreneurship education promote entrepreneurial intention? The role of social media and entrepreneurial intuition. Social Sci Humanit Open Elsevier. 2023;8:100681. https://doi.org/10.1016/j.ssaho.2023.100681.
31. Kolvereid L. Prediction of Employment Status Choice Intentions. Entrepreneurship Theory Pract. 1996;21:47–58. https://doi.org/10.1177/104225879602100104.
32. Autio E, Keeley RH, Klofsten M, Parker GC, Hay M. Entrepreneurial intent among students in Scandinavia and in the USA. Enterp Innov Manage Stud. 2001;2:145–60. https://doi.org/10.1080/14632440110094632.
33. Solesvik MZ. Entrepreneurial motivations and intentions: investigating the role of education major. Education and Training. Emerald Group Publishing Ltd. 2013;55:253–71. https://doi.org/10.1108/00400911311309314.
34. Cardon MS, Grégoire DA, Stevens CE, Patel PC. Measuring entrepreneurial passion: Conceptual foundations and scale validation. J Bus venturing Elsevier. 2013;28:373–96. https://doi.org/10.1016/j.jbusvent.2012.03.003.
35. Sinclair VG, Wallston KA. The development and psychometric evaluation of the Brief Resilient Coping Scale. Assessment. 2004;11:94–101. https://doi.org/10.1177/1073191103258144.

36. Shen J, Benson J. When CSR Is a Social Norm: How Socially Responsible Human Resource Management Affects Employee Work Behavior. J Manag. 2016;42:1723–46. https://doi.org/10.1177/0149206314522300.
37. Liñán F. Intention-based models of entrepreneurship education. Piccolla Impresa/Small Bus. 2004;3:11–35.
38. Vejayaratnam N, Paramasivam T, Mustakim SS. Digital entrepreneurial intention among private Technical and Vocational Education (TVET) Students. Int J Acad Res Bus Social Sci. 2019;9:110–20. https://doi.org/10.6007/IJARBSS/v9-i12/6678.
39. Brislin RW. Back-Translation for Cross-Cultural Research. J Cross-Cult Psychol. 1970;1:185–216. https://doi.org/10.1177/135910457000100301.
40. Kock N. Common method bias in PLS-SEM: A full collinearity assessment approach. Int J e-Collaboration IGI Global Sci Publishing. 2015;11:1–10. https://doi.org/10.4018/ijec.2015100101.
41. Podsakoff PM, MacKenzie SB, Lee J-Y, Podsakoff NP. Common method biases in behavioral research: A critical review of the literature and recommended remedies. J Appl Psychol. 2003;88:879–903. https://doi.org/10.1037/0021-9010.88.5.879.
42. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. J Mark Res. 1981;18:39–50. https://doi.org/10.1177/002224378101800104.
43. Henseler J, Ringle CM, Sarstedt M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. J Acad Mark Sci Germany: Springer. 2015;43:115–35. https://doi.org/10.1007/s11747-014-0403-8.
44. Shmueli G, Sarstedt M, Hair JF, Cheah J-H, Ting H, Vaithilingam S, et al. Predictive model assessment in PLS-SEM: guidelines for using PLSpredict. European journal of marketing. Emerald Publishing Ltd. 2019;53:2322–47. https://doi.org/10.1108/EJM-02-2019-0189.
45. Henseler J, Ringle CM, Sarstedt M. Testing measurement invariance of composites using partial least squares. R. Sinkovics R-J Bryan J and DK Rudolf, editor. International Marketing Review. 2016;33:405–31. https://doi.org/10.1108/IMR-09-2014-0304
46. Matthews L, Hair J, Matthews R. PLS-SEM: The holy grail for advanced analysis. Marketing management journal. Mark Manage Association. 2018;28:1–13. https://doi.org/10.63963/001c.151119.
47. Dul J, van der Laan E, Kuik R. A Statistical Significance Test for Necessary Condition Analysis. Organizational Research Methods. Volume 23. SAGE Publications Inc; 2020. pp. 385–95. https://doi.org/10.1177/1094428118795272.
48. Hoang G, Le TTT, Tran AKT, Du T. Entrepreneurship education and entrepreneurial intentions of university students in Vietnam: The mediating roles of self-efficacy and learning orientation. Educ Train Emerald Publishing Ltd. 2021;63:115–33. https://doi.org/10.1108/ET-05-2020-0142.
49. Hoang G, Luu TT, Le TTT, Tran N, Tran AKT. Examining the effects of entrepreneurship education on entrepreneurial intentions of Vietnamese business students: The roles of entrepreneurial alertness and resilience. J Educ Bus. 2023;98:462–70. https://doi.org/10.1080/08832323.2023.2232921.

50. Mukhtar S, Wardana LW, Wibowo A, Narmaditya BS. Does entrepreneurship education and culture promote students' entrepreneurial intention? The mediating role of entrepreneurial mindset. Cheng M, editor. Cogent Education. 2021;8:1918849. https://doi.org/10.1080/2331186X.2021.1918849
51. Hobfoll SE. Conservation of resources: a new attempt at conceptualizing stress. American psychologist. Am Psychol Association. 1989;44:513–24. https://doi.org/10.1037/0003-066X.44.3.513.
52. Hofstede G, Hofstede GJ, Minkov M. Cultures and Organizations: Software of the Mind, revised and expanded. 3rd ed. Berkshire: McGraw-Hill; 2010.
53. Tsou E, Steel P, Osiyevskyy O. The relationship between entrepreneurial intention and behavior: A meta-analytic review. Int J Entrepreneurship Innov SAGE Publications. 2023;14657503231214389. https://doi.org/10.1177/14657503231214389.

Figures

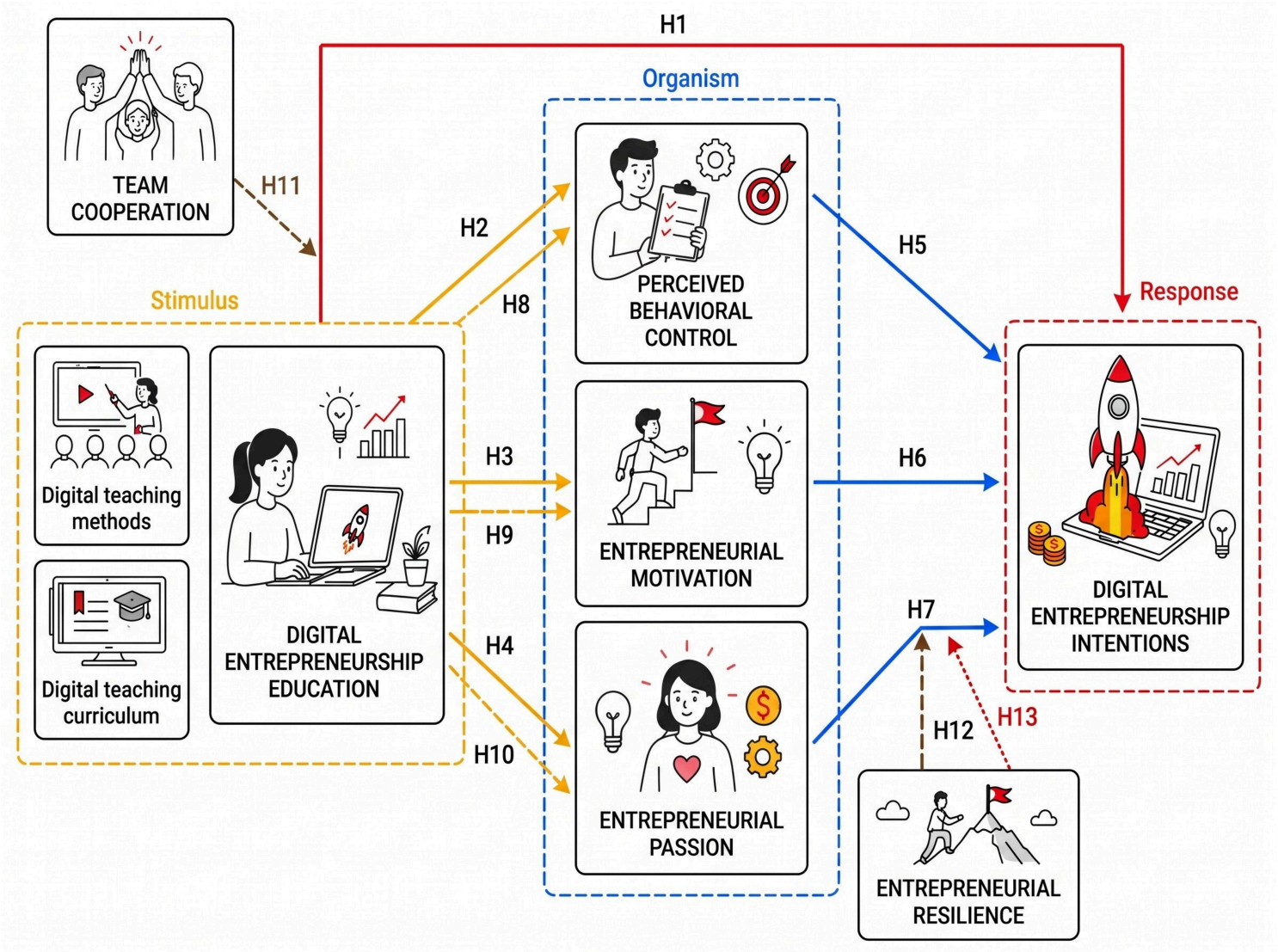


Figure 1

Conceptual model. Digital teaching methods and digital teaching curriculum denote the content domains covered by the unidimensional DEE measure and are not modeled as separate latent dimensions.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table1.docx
- Table2.docx
- Table3.docx
- Table4.docx
- Table5.docx
- Table6.docx
- Table7.docx
- Table8.docx
- Table9.docx
- SupplementaryMaterials.docx