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From Mental Wellbeing to Sustainable Action: The Role of Burnout and Systems Thinking in Shaping University Entrepreneurs—A PLS-SEM Approach

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Abstract

Universities play a pivotal role in preparing future leaders capable of addressing complex sustainability challenges. This study examines how mental wellbeing and academic burnout affect sustainable entrepreneurship attitude (SEA) among university students, with systems thinking acting as a mediating competency. Drawing on a sample of 367 students from three universities in northeastern Mexico, PLS-SEM was applied to test a six-hypothesis model. Results confirm that mental wellbeing positively influences both systems thinking ($\beta = 0.31, p < 0.001$) and sustainable entrepreneurship attitude ($\beta = 0.28, p < 0.001$), while burnout exerts a detrimental structural association with both dimensions. Systems thinking partially mediates these relationships. The model explains 48% of the variance in SEA. These findings reinforce the importance of integrating psychological support and cognitive training into higher education programs, with direct implications for SDG 3, SDG 4, and SDG 8.

Keywords: sustainable entrepreneurship; mental wellbeing; academic burnout; systems thinking; higher education; sustainability education; PLS-SEM; Mexico; SDGs

1. Introduction

The global imperative to achieve the United Nations Sustainable Development Goals (SDGs) by 2030 has significantly elevated the role of entrepreneurship as a catalyst for social, economic, and environmental transformation [1]. Entrepreneurship, when oriented toward sustainability, can generate systemic innovations that address complex challenges related to climate change, inequality, and resource depletion [2,3]. Universities have consequently assumed a central position in this transition, embedding sustainability principles into entrepreneurship curricula and seeking to develop graduates capable of integrating ecological, social, and economic values into their ventures [4,5].

Despite this growing institutional commitment, most educational models focus primarily on technical competencies and business skills, often neglecting the psychological and cognitive factors that underpin sustainability-oriented action [6]. Research increasingly demonstrates that students' emotional wellbeing and cognitive complexity, particularly their capacity for systems thinking, are critical determinants of their ability to envision and engage in sustainable entrepreneurship [7–9]. This suggests that the formation of sustainable entrepreneurial intention is not merely an educational or motivational process, but also a deeply psychological and cognitive one.

Academic burnout, defined as a state of chronic stress manifested through emotional exhaustion, cynicism, and reduced personal accomplishment, represents a particularly



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salient barrier in contemporary university environments [10–12]. A growing body of evidence documents escalating rates of burnout among university students globally [13]. At the same time, positive mental health—characterized by emotional vitality, psychological functioning, and a sense of purpose—has been associated with higher levels of proactive behavior, creativity, and long-term thinking [14,15].

Systems thinking is the cognitive capacity to understand dynamic, interconnected systems and anticipate emergent consequences, and has been widely recognized as a foundational competency in education for sustainable development [8]. Wiek et al. [8] positioned it as the centerpiece of sustainability literacy in higher education, a view reaffirmed by Brundiers et al. [7] and by Redman and Wiek [9]. However, empirical research examining how psychological states condition students' capacity to develop and apply systems thinking remains sparse [8,9,16].

This study addresses this gap by proposing and testing an integrative model in which mental wellbeing and burnout function as affective antecedents of systems thinking, which in turn shapes students' sustainable entrepreneurship attitude (SEA). By applying PLS-SEM to a sample of Mexican university students, this research offers empirical evidence on the interplay between psychological, cognitive, and attitudinal dimensions of sustainable entrepreneurial formation.

This study makes three distinct contributions. First, it integrates mental wellbeing, academic burnout, and systems thinking into a single empirically testable model of sustainable entrepreneurship attitude formation, an integration not previously tested in the sustainability education or entrepreneurial cognition literature [6–8]. Second, it advances theory by conceptualizing systems thinking not merely as an outcome of sustainability education, but as a cognitive mediating mechanism through which affective states are translated into sustainability-oriented entrepreneurial attitudes, bridging sustainability competency frameworks [8,9] with psychological antecedent models of entrepreneurial cognition [17]. Third, it strengthens the connection between higher education research and the SDG agenda: mental wellbeing supports SDG 3 (Good Health and Wellbeing) and SDG 4 (Quality Education), and through its positive structural association with SEA, a key driver of sustainability-oriented ventures [18], contributes to SDG 8 (Decent Work and Economic Growth) [1,4,18].

The remainder of this paper is organized as follows. Section 2 presents the theoretical framework and research hypotheses. Section 3 describes the methodology. Section 4 reports the results. Section 5 discusses the findings. Section 6 outlines implications. Section 7 acknowledges limitations. Section 8 concludes.

2. Theoretical Framework and Hypotheses

2.1. Mental Wellbeing and Sustainable Entrepreneurial Attitude

Mental wellbeing is a multidimensional construct encompassing emotional vitality, psychological functioning, positive interpersonal relationships, and a sense of personal meaning and growth [19]. Classic frameworks, including Ryff's eudaimonic model [20] and the Warwick–Edinburgh Mental Wellbeing Scale (WEMWBS) [10], operationalize wellbeing as a composite of hedonic and eudaimonic dimensions that together predict adaptive behavior and purposeful engagement.

The broaden-and-build theory [21] provides a particularly relevant theoretical anchor: positive affect broadens individuals' attentional scope and cognitive repertoire, enabling flexible information processing, integrative problem-solving, and long-term orientation [14,22]. Stephan's [23] review identified a consistent positive link between entrepreneurs' wellbeing and ethical, purpose-driven, and long-term-oriented business behavior. On this basis:

Hypotheses 1 (H1). *Mental wellbeing is positively associated with students' sustainable entrepreneurship attitude.*

2.2. Burnout and Its Detrimental Effects on Sustainability Intentions

Academic burnout encompasses emotional exhaustion from academic demands, cynicism toward studies, and a sense of diminished academic efficacy [12,14]. Longitudinal evidence demonstrates that burnout trajectories during university studies are associated with disengagement and withdrawal from challenging academic activities [10,24]. Conservation of Resources (COR) theory [25,26] explains how resource depletion narrows behavioral and cognitive repertoire, discouraging investment in effortful, long-term endeavors such as sustainability-oriented ventures [12,24,25,27].

Hypotheses 2 (H2). *Burnout is negatively associated with students' sustainable entrepreneurship attitude.*

2.3. Systems Thinking as a Core Sustainability Competency

Systems thinking is defined as the cognitive capacity to analyze the structure and dynamics of complex systems, identify feedback loops, and reason about long-term consequences of decisions [8,28]. Wiek et al. [8] positioned it as the centerpiece of sustainability literacy, reaffirmed by Brundiers et al. [7] and Redman and Wiek [9]. Empirical work confirms that students with higher systems thinking scores are more likely to express intentions toward sustainable entrepreneurship [23,29,30].

A compelling implication of updated sustainability competency frameworks is that systems thinking may function as a cognitive hub through which affective states are channeled into sustainability-relevant action, specifically into what Ploum et al. [4,31] define as a sustainable entrepreneurship attitude (SEA): a dispositional orientation toward entrepreneurial action that integrates social, environmental, and economic value creation. SEA is conceptually distinct from conventional entrepreneurial intention as operationalized by Liñán and Chen [32], which centers on the decision to create a venture without embedding sustainability as a constitutive motivational element [4,31,32]. The construct measured in this study follows Ploum et al.'s validated operationalization [4,31].

Hypotheses 3 (H3). *Systems thinking is positively associated with students' sustainable entrepreneurship attitude.*

2.4. Affective States as Antecedents of Systems Thinking

The broaden-and-build theory [21] predicts that positive affect expands cognitive scope and promotes integrative, flexible problem-solving, precisely the mode of thought underlying systems thinking [13,14,22]. Conversely, the resource depletion associated with burnout directly undermines the cognitive prerequisites for systems thinking [25,26]: emotional exhaustion reduces working memory capacity, attentional control, and cognitive flexibility [12,20,27]. Sustainability education scholars have explicitly called for greater attention to these affective dimensions as conditioning factors [6,33].

Hypotheses 4 (H4). *Mental wellbeing is positively associated with systems thinking.*

Hypotheses 5 (H5). *Burnout is negatively associated with systems thinking.*

2.5. The Mediating Role of Systems Thinking

Dual-process models in entrepreneurial cognition propose that affective states influence effortful deliberative processes, which in turn shape behavioral intention [17,34,35]. Systems thinking may function as the cognitive bridge between emotional wellbeing (or its absence) and the motivational commitment to pursue sustainable entrepreneurship [17].

This mediation logic is consistent with the intrapersonal competency dimension identified by Redman and Wiek [9], which encompasses the capacity to avoid burnout and maintain psychological resilience [9].

Hypotheses 6a (H6a). *Systems thinking mediates the structural relationship between mental wellbeing and sustainable entrepreneurship attitude.*

Hypotheses 6b (H6b). *Systems thinking mediates the structural relationship between burnout and sustainable entrepreneurship attitude.*

2.6. Conceptual Model

The hypotheses above are represented in the following conceptual model, illustrating both direct paths (H1–H5) and mediated paths (H6a–H6b) through systems thinking as the central cognitive mediator (See Figure 1).

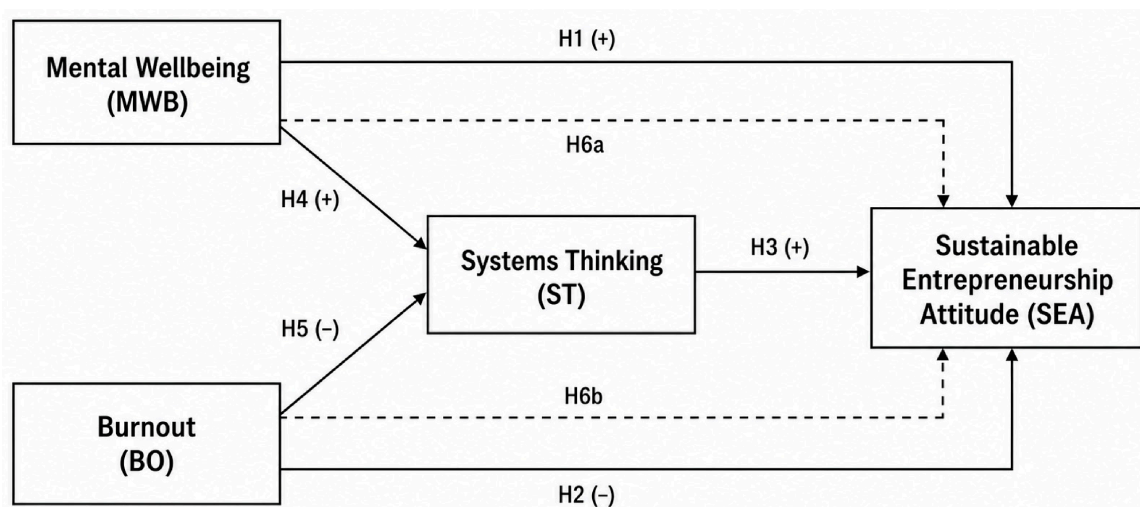


Figure 1. Conceptual model with hypothesized paths H1–H6b.

Prior studies have addressed systems thinking primarily as a core sustainability competency to be developed through higher education processes [7–9]. However, its role within entrepreneurship-oriented contexts remains less explicitly integrated at the structural level, even though previous work has linked sustainability competencies, entrepreneurial cognition, and sustainability-oriented venturing [4,11,29,30]. Building on this literature, the present study positions systems thinking not only as an educational outcome, but as a mediating cognitive pathway through which affective conditions, specifically mental wellbeing and burnout, are structurally associated with sustainable entrepreneurship attitude [8,9,17]. This framing is also consistent with the intrapersonal competency perspective, which emphasizes psychological resilience and burnout prevention as enabling conditions for sustainability action [9]. From a methodological standpoint, the use of PLS-SEM is aligned with prior applications in sustainability- and entrepreneurship-related educational research involving latent constructs, mediation paths, and exploratory explanatory models [19,36–38].

3. Materials and Methods

3.1. Research Design

This study employed a quantitative, cross-sectional, explanatory design. The analytical method was Partial Least Squares Structural Equation Modeling (PLS-SEM), selected for its suitability in evaluating complex models with latent variables, reflective constructs, and indirect effects, particularly when the objective is exploratory explanation and prediction rather than confirmatory theory testing [19,28,35,36].

PLS-SEM was preferred over covariance-based SEM (CB-SEM) for three reasons: (1) the model is theory-exploratory rather than confirmatory, making predictive accuracy a primary criterion [19,39]; (2) PLS-SEM performs well under conditions of non-normal data distributions and complex mediation structures [38]; and (3) the sample size and model complexity are well-suited to PLS-SEM's algorithmic requirements [38]. SmartPLS 4.0 [40] was used for all estimation and bootstrapping procedures.

A large-language-model-based writing assistant (Perplexity AI) was used only to support English language editing. The AI tool was not used to generate or modify the study's research questions, theoretical framework, methodology, data analysis, results, or interpretation.

3.2. Population and Sample

The study followed the ethical principles of the Declaration of Helsinki and the internal guidelines for research involving human participants at Universidad de Monterrey; participation was anonymous and voluntary, and no directly identifiable personal data were collected.

Data collection took place between April and June 2025 via an online questionnaire distributed through institutional learning management systems, student associations, and faculty networks. Approximately 510 students were initially contacted, yielding 412 raw responses (response rate $\approx 81\%$). Of these, 45 questionnaires were excluded due to incompleteness (missing more than 10% of items) or evidence of straight-lining (identical responses across five or more consecutive items), leaving 367 valid responses. Respondents were distributed across the three participating institutions as follows: Universidad de Monterrey—UDEM (48%), Tecnológico de Monterrey (28%), and Universidad Regiomontana (24%). Approximately 72% were undergraduate students and 28% were enrolled in graduate programs.

The demographic profile was 59% female and 41% male, with a mean age of 22.4 years ($SD = 2.6$). Approximately 68% of respondents were enrolled in business-related programs, while 32% were in engineering or social sciences with sustainability components in their curricula. A non-probabilistic purposive sampling approach was adopted [34].

3.3. Measurement Instruments

The survey instrument was structured around four latent constructs (Table 1), all measured with validated scales adapted from the peer-reviewed literature. Items were scored on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). The instrument was pre-tested with a convenience subsample of 30 students prior to full deployment [41].

All scales were originally in English and were translated into Spanish following a forward–backward translation protocol consistent with cross-cultural adaptation best practices [42]: two bilingual academics independently translated the items; discrepancies were resolved through consensus; and a back-translation was reviewed for equivalence by a third bilingual expert [12,19,42]. Reverse-coded items (BO_3R, BO_5R) were re-coded prior to analysis so that higher scores consistently reflect higher burnout levels [12].

Table 1. Complete measurement items for all four constructs.

Construct	Item Code	Item Text (English)	Source
Mental Wellbeing (MWB)	MWB_1	I have been feeling optimistic about the future.	Tennant et al. (2007) [10]
Mental Wellbeing (MWB)	MWB_2	I have been feeling useful.	Tennant et al. (2007) [10]
Mental Wellbeing (MWB)	MWB_3	I have been feeling relaxed.	Tennant et al. (2007) [10]
Mental Wellbeing (MWB)	MWB_4	I have been dealing with problems well.	Tennant et al. (2007) [10]

Table 1. *Cont.*

Construct	Item Code	Item Text (English)	Source
Mental Wellbeing (MWB)	MWB_5	I have been thinking clearly.	Tennant et al. (2007) [10]
Mental Wellbeing (MWB)	MWB_6	I have been feeling close to other people.	Tennant et al. (2007) [10]
Mental Wellbeing (MWB)	MWB_7	I have been able to make up my own mind about things.	Tennant et al. (2007) [10]
Burnout (BO)	BO_1	I feel emotionally drained by my academic activities.	Schaufeli et al. (2002) [12]
Burnout (BO)	BO_2	I feel burned out by my studies.	Schaufeli et al. (2002) [12]
Burnout (BO)	BO_3R	I feel enthusiastic about my studies. (R)	Schaufeli et al. (2002) [12]
Burnout (BO)	BO_4	I doubt the significance of my studies.	Schaufeli et al. (2002) [12]
Burnout (BO)	BO_5R	I feel stimulated when I achieve something in my studies. (R)	Schaufeli et al. (2002) [12]
Systems Thinking (ST)	ST_1	I am able to see how events in a system are interconnected.	Wiek et al. (2011) [8]; Brundiers et al. (2021) [7]
Systems Thinking (ST)	ST_2	I can identify the long-term consequences of actions in a complex system.	Wiek et al. (2011) [8]
Systems Thinking (ST)	ST_3	I understand how changes in one part of a system affect other parts.	Brundiers et al. (2021) [7]
Systems Thinking (ST)	ST_4	I can recognize feedback loops and unintended consequences.	Redman & Wiek (2021) [9]
Sustainable Entrepreneurship Attitude (SEA)	SEA_1	I want to start a business that contributes positively to environmental sustainability.	Ploum et al. (2018) [4]
Sustainable Entrepreneurship Attitude (SEA)	SEA_2	I am motivated to create ventures that address social and environmental problems.	Ploum et al. (2018) [4]
Sustainable Entrepreneurship Attitude (SEA)	SEA_3	I believe economic growth and environmental responsibility can be combined in a business.	Ploum et al. (2018) [4]
Sustainable Entrepreneurship Attitude (SEA)	SEA_4	I would prefer a business that generates social impact over one that maximizes profit alone.	Ploum et al. (2018) [4]
Sustainable Entrepreneurship Attitude (SEA)	SEA_5	I feel personally committed to developing entrepreneurial solutions to sustainability challenges.	Ploum et al. (2018) [4]

Note: (R) = reverse-coded item, re-coded prior to analysis. SEA = sustainable entrepreneurship attitude. The SEA construct measures attitude toward entrepreneurial action that explicitly integrates social, environmental, and economic value creation, consistent with Ploum et al. [4] validated operationalization. This is conceptually distinct from conventional entrepreneurial intention, which does not embed sustainability as a constitutive element [4,43,44].

3.4. Data Collection and Ethical Considerations

Data collection was conducted via an online questionnaire administered through institutional learning management systems, student associations, and faculty networks. Participation was entirely voluntary, and informed digital consent was obtained at the beginning of each survey. No personally identifiable information was collected. The study was conducted in accordance with the ethical guidelines of the authors' institution and followed the Declaration of Helsinki principles for research involving human participants.

To mitigate common method bias (CMB), procedural remedies were implemented including reverse-coded items for construct balance and explicit assurance of response anonymity [45]. Post hoc diagnostics included: (1) Harman's single-factor test—no single factor exceeded 30% of total variance (exploratory diagnostic only [45]); and (2) full collinearity VIF assessment following Kock [46]—all construct-level VIF values fell below 3.3, indicating that CMB is unlikely to constitute a serious threat [46]. These combined

remedies reduce the probability that method-related artifacts drive the observed results, although they do not constitute definitive proof of the absence of CMB [45,46].

3.5. Analytical Procedure

The PLS-SEM analysis followed the established two-step evaluation procedure [19,28,35]. Step 1—measurement model: Cronbach’s alpha, Composite Reliability, AVE (>0.50), and HTMT ratio. Step 2—structural model: path coefficients (β) with 95% bootstrapped confidence intervals (5000 resamples), R^2 , f^2 , Q^2 via blindfolding, and SRMR as a global fit index.

A sensitivity analysis was conducted by comparing the full model (MWB, BO $\rightarrow$ ST $\rightarrow$ SEA) with a reduced model (MWB, BO $\rightarrow$ SEA directly) to assess the robustness of the mediation pattern. A 10-fold cross-validated predictive assessment analogous to PLSpredict [39] was also implemented to evaluate out-of-sample predictive accuracy for SEA. Missing data represented less than 2% of responses across retained items and were handled via mean imputation at the construct level prior to PLS-SEM estimation.

4. Results

4.1. Measurement Model

Evaluation of the measurement model revealed strong psychometric properties for all four constructs, as summarized in Table 2. Composite Reliability (CR) and Cronbach’s alpha exceeded the 0.70 threshold for all constructs, and Average Variance Extracted (AVE) values surpassed the minimum criterion of 0.50, confirming convergent validity [28,35].

Table 2. Measurement model results: reliability and convergent validity.

Construct	Items	Cronbach’s α	CR	AVE
Mental Wellbeing (MWB)	7	0.89	0.91	0.63
Burnout (BO)	5	0.85	0.88	0.59
Systems Thinking (ST)	4	0.87	0.90	0.61
Sustainable Entrepreneurship Attitude (SEA)	5	0.86	0.89	0.66

All standardized indicator loadings exceeded 0.70 and were statistically significant at the $p < 0.001$ level, satisfying the criterion for individual item reliability. No cross-loadings exceeded the construct’s own loadings, providing preliminary evidence of discriminant validity (Table 3).

Table 3. Item-level outer loadings and bootstrapped 95% CIs.

Item	Outer Loading	95% CI Lower	95% CI Upper
MWB_1	0.78	0.71	0.85
MWB_2	0.81	0.75	0.87
MWB_3	0.76	0.69	0.83
MWB_4	0.83	0.77	0.89
MWB_5	0.80	0.73	0.87
MWB_6	0.75	0.68	0.82
MWB_7	0.79	0.72	0.86
BO_1	0.77	0.70	0.84
BO_2	0.82	0.75	0.89

Table 3. *Cont.*

Item	Outer Loading	95% CI Lower	95% CI Upper
BO_3R	0.74	0.67	0.81
BO_4	0.78	0.71	0.85
BO_5R	0.75	0.68	0.82
ST_1	0.80	0.73	0.87
ST_2	0.79	0.72	0.86
ST_3	0.81	0.74	0.88
ST_4	0.77	0.70	0.84
SEA_1	0.84	0.78	0.90
SEA_2	0.82	0.76	0.88
SEA_3	0.79	0.72	0.86
SEA_4	0.81	0.74	0.88
SEA_5	0.83	0.77	0.89

Note: Outer loadings and 95% CIs estimated via percentile bootstrapping (5000 resamples). All loadings exceed the 0.70 threshold [19].

Discriminant validity was assessed using the HTMT ratio criterion [22]. As shown in Table 4, all HTMT values fell below the 0.85 threshold, confirming construct distinctiveness [28].

Table 4. Discriminant validity Heterotrait–Monotrait (HTMT) ratio matrix.

	MWB	BO	ST	SEA
Mental Wellbeing (MWB)				
Burnout (BO)	0.49			
Systems Thinking (ST)	0.52	0.45		
Sustainable Entrepreneurship Attitude (SEA)	0.58	0.47	0.64	

Note: All values below the 0.85 HTMT threshold confirm construct distinctiveness [21].

4.2. Structural Model

VIF values for all predictor variables fell below 3.0, indicating no multicollinearity concerns [19]. R^2 (Systems Thinking) = 0.42; R^2 (SEA) = 0.48.

The SRMR value was 0.063, below the 0.08 threshold recommended by Hair et al. [19] and Shmueli et al. [39], indicating acceptable global model fit [19,36,39]. Q^2 values exceeded 0.25 for both endogenous constructs, confirming medium predictive relevance [19]. As illustrated in Figure 2, the structural model shows standardized path coefficients ranging from 0.19 to 0.35 for the hypothesized relationships between wellbeing, burnout, systems thinking, and SEA. As shown in Table 5, the direct path coefficients, bootstrapped confidence intervals, and hypothesis testing results indicate that all hypothesized structural associations (H1–H5) are statistically significant, with standardized coefficients ranging from -0.24 to 0.35 .

Table 6 reports VIF values and Cohens f^2 effect sizes for each path. Effect sizes (f^2) range from 0.09 to 0.17, indicating small-to-medium practical significance [35].

It is important to note that, while all paths are statistically significant, f^2 values are in the small-to-medium range, indicating that additional variables likely explain a non-trivial portion of variance in SEA. This boundary condition is reflected in the interpretation of practical implications.

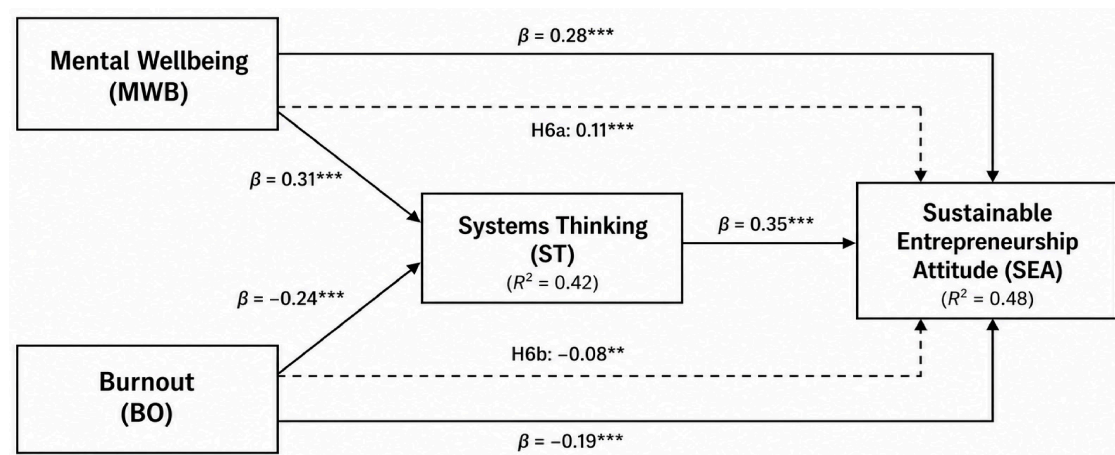


Figure 2. Structural model with standardized path coefficients. *** $p < 0.001$; ** $p < 0.01$.

Table 5. Direct path coefficients, bootstrapped 95% CIs, and hypothesis testing.

Hypothesis	Path	β	t-Value	p-Value	95% CI	Supported
H1	MWB $\rightarrow$ SEA	0.28	4.76	<0.001	[0.17, 0.39]	Yes
H2	BO $\rightarrow$ SEA	−0.19	3.87	<0.001	[−0.29, −0.09]	Yes
H3	ST $\rightarrow$ SEA	0.35	5.24	<0.001	[0.22, 0.48]	Yes
H4	MWB $\rightarrow$ ST	0.31	5.62	<0.001	[0.20, 0.42]	Yes
H5	BO $\rightarrow$ ST	−0.24	4.11	<0.001	[−0.36, −0.13]	Yes

Note: Bootstrapping 5000 resamples; two-tailed. All paths reflect structural associations within the hypothesized model consistent with the cross-sectional design; causal language is intentionally avoided [19,39].

Table 6. VIF values and Cohen's f^2 effect sizes.

Hypothesis	Path	VIF (Predictor)	β	f^2
H1	MWB $\rightarrow$ SEA	1.38	0.28	0.12
H2	BO $\rightarrow$ SEA	1.42	−0.19	0.09
H3	ST $\rightarrow$ SEA	1.55	0.35	0.17
H4	MWB $\rightarrow$ ST	1.28	0.31	0.14
H5	BO $\rightarrow$ ST	1.28	−0.24	0.11

Note: f^2 benchmarks: 0.02 = small, 0.15 = medium, 0.35 = large [35].

4.3. Mediation Analysis

Bootstrapped indirect effects were computed to test H6a and H6b. Results confirmed that systems thinking mediates the structural relationships of both mental wellbeing and burnout on sustainable entrepreneurship attitude (Table 7).

Table 7. Mediation analysis: bootstrapped indirect effects.

Hypothesis	Mediation Path	Indirect Effect (β)	t-Value	p-Value	95% CI	Type
H6a	MWB $\rightarrow$ ST $\rightarrow$ SEA	0.11	3.43	<0.001	[0.05, 0.17]	Partial
H6b	BO $\rightarrow$ ST $\rightarrow$ SEA	−0.08	3.05	0.002	[−0.14, −0.03]	Partial

Note: 95% CIs via percentile bootstrapping (5000 resamples). Partial mediation: both direct and indirect effects significant [35].

As shown in Table 8, a sensitivity analysis comparing a reduced model without systems thinking to the full model indicates that including systems thinking substantially

increases the explained variance in SEA and reduces the direct effect of mental wellbeing on SEA, consistent with partial mediation.

Table 8. Sensitivity analysis: full vs. reduced model.

Model	Specification	R ² (SEA)	β MWB $\rightarrow$ SEA
Reduced	SEA ~ MWB + BO	0.23	0.59
Full	SEA ~ MWB + BO + ST	0.48	0.28

Note: Higher R² and reduced direct effect in the full model confirm the robustness of the mediation pattern.

As reported in Table 9, a 10-fold cross-validated predictive assessment shows that the full model yields a slightly lower RMSE for SEA than the benchmark model, indicating small but meaningful incremental predictive accuracy.

Table 9. Predictive assessment: 10-fold cross-validated RMSE for SEA.

Prediction Model	Mean RMSE	SD RMSE
Full model (MWB, BO, ST $\rightarrow$ SEA)	0.669	0.198
Benchmark (MWB, BO $\rightarrow$ SEA only)	0.685	0.191

Note: Lower RMSE = better predictive accuracy. Full model provides incremental predictive value over the benchmark. Analysis conducted following PLSpredict guidelines [39].

5. Discussion

5.1. The Enabling Role of Mental Wellbeing

The finding that mental wellbeing is structurally associated with both systems thinking and sustainable entrepreneurship attitude extends prior research across three streams. First, the broaden-and-build theory [21] predicts that positive affect expands cognitive resources supporting integrative reasoning [14,22]; the present $\beta = 0.31$ for MWB $\rightarrow$ ST provides empirical support for this prediction in the sustainability education domain. Second, Stephan's [23] review confirmed links between entrepreneurs' wellbeing and ethical, purpose-driven behavior; this study extends that finding to the formative stage before entrepreneurial activity begins. Third, the indirect path MWB $\rightarrow$ ST $\rightarrow$ SEA ($\beta = 0.11$, 95% CI [0.05, 0.17]) repositions systems thinking as a cognitive channel between wellbeing and SEA—bridging positive psychology and sustainability competency theory in a configuration not previously tested [8,9,21]. Institutional investments in student mental health are therefore strategic enablers of sustainability-oriented human capital development [4,47].

The implications for SDG 8 are equally significant: sustainable entrepreneurship—which Shepherd and Patzelt [18] define as entrepreneurial action simultaneously addressing social and environmental sustainability while generating economic value—is structurally associated in this model with both wellbeing and systems thinking. University policies that prevent burnout and foster wellbeing thus contribute indirectly but meaningfully to SDG 8 targets on inclusive growth and decent work [1,4,18].

5.2. Burnout as a Structural Barrier to Sustainability Action

Burnout's negative structural associations with both systems thinking and SEA are consistent with COR theory [25,26]. Resource depletion through chronic academic stress reduces students' cognitive and motivational capacity for engaging with complex, long-term sustainability challenges [12,21,24,25,27]. The indirect structural path through systems thinking (H6b) adds an important nuance: burnout is associated not only with lower SEA directly but also with reduced systems thinking capacity—a 'double depletion' pattern [15,16].

These findings support calls for systematic burnout prevention as a prerequisite for developing the cognitive competencies that sustainability education aims to cultivate [15,46].

5.3. Systems Thinking as a Cognitive Mediator

The partial mediation of systems thinking represents the most theoretically novel contribution of this study: systems thinking had not previously been empirically validated at the structural level as a cognitive transmission pathway through which psychological resources are converted into sustainability-oriented attitudinal dispositions [7–9,16]. The partial (rather than full) mediation pattern indicates that affective states are structurally associated with SEA through both the cognitive pathway of systems thinking and more direct motivational routes [17,34,35,48].

The observed $\beta = 0.35$ for $ST \rightarrow SEA$ represents the strongest direct structural association in the model, reinforcing prior work on systems thinking as a predictor of sustainable entrepreneurial intention [23,29,30]. The present study extends these findings by situating systems thinking within a psychological antecedent model.

5.4. Integrated Model Implications for Sustainability Education Theory

Taken together, the validated model advances sustainability education theory in three ways: (1) demonstrating that sustainability competency formation is conditioned by affective states; (2) identifying systems thinking as a structural mediating pathway from emotional wellbeing to sustainability-oriented attitudes; and (3) lending quantitative support to the intrapersonal competency dimension proposed by Redman and Wiek [9], specifically that burnout prevention and psychological resilience are foundational prerequisites for sustainability action [8,16].

6. Theoretical and Practical Implications

6.1. Theoretical Contributions

This study makes three primary theoretical contributions. First, it integrates wellbeing, burnout, and systems thinking into a single empirically testable model of SEA formation, addressing a recognized gap at the intersection of sustainability education, entrepreneurial cognition, and educational psychology [1,6,7]. The novelty lies in the empirical validation of systems thinking as a mediating cognitive mechanism rather than solely an educational outcome through which affective conditions are translated into sustainability-oriented attitudes [8,9,17]. This extends prior entrepreneurial intention models [32] by embedding sustainability competencies as mediators. Second, it provides empirical support for the intrapersonal competency dimension in Redman and Wiek's [9] framework. Third, it demonstrates the utility of PLS-SEM [19,40] for modeling complex mediated structures with latent psychological constructs in sustainability education research [38].

6.2. Practical Implications for Higher Education Institutions

Several actionable recommendations emerge for universities, educators, and policymakers:

1. Institutional mental health support: proactive investment in mental health services, stress reduction programs, and flexible academic policies are both welfare interventions and strategic competency development investments given the direct and indirect structural associations of wellbeing with SEA.
2. Burnout monitoring and early intervention: regular screening using validated instruments such as the MBI-SS should be integrated into program monitoring, particularly in high-demand programs [12,15].
3. Experiential systems thinking pedagogy: causal loop diagram workshops, complex case analysis, stakeholder mapping, and cross-disciplinary project-based learn-

- ing promote systems thinking and activate cognitive processes associated with SEA formation [29,30].
4. Holistic competency curricula: curricula should incorporate both cognitive competency development and emotional–psychological development, aligning with the SDG 4 mandate for quality education [4,47].
 5. Interdisciplinary program design: exposure to diverse disciplinary perspectives fosters stronger systems thinking capacity [8,16].

7. Limitations and Future Research

7.1. Methodological Constraints

The use of a non-probabilistic convenience sample from three universities in northeastern Mexico limits generalizability [34]. Future studies should replicate this model across culturally diverse contexts.

The cross-sectional design restricts causal inference. Because the design is cross-sectional and all data are self-reported, the structural paths reported here reflect associations consistent with the hypothesized model and should not be interpreted as evidence of temporal or causal ordering [10,25]. Longitudinal and quasi-experimental designs would provide stronger evidence for directionality.

7.2. Measurement Limitations

Although procedural remedies and full collinearity VIF assessment following Kock [46] were used to diagnose common method bias, future studies should also employ the marker variable approach [45] for additional robustness. Additionally, systems thinking and SEA operationalizations are still evolving [8,32]; future research could complement survey data with behavioral assessments or learning portfolios.

7.3. Theoretical Extensions

Future research could enrich the framework by incorporating additional antecedents (climate anxiety, ecological identity, self-efficacy) and additional sustainability competency mediators (future thinking, normative competency, strategic action competency, all elements of the Redman–Wiek framework [9]). Moderating variables including pedagogical exposure and institutional sustainability commitment also merit investigation [8,45,49].

8. Conclusions

This study presents and empirically validates an integrative framework linking mental wellbeing, academic burnout, systems thinking, and sustainable entrepreneurship attitude (SEA) among university students in Mexico. The PLS-SEM analysis confirmed all six hypotheses, demonstrating structural associations consistent with the hypothesized model: (1) mental wellbeing is positively associated with both ST and SEA; (2) burnout is negatively associated with both; (3) ST is the strongest structural predictor of SEA; and (4) ST partially mediates the structural relationships of wellbeing and burnout on SEA. Because the design is cross-sectional, findings reflect associations consistent with the theoretical model and do not establish causal ordering.

The theoretical significance lies in demonstrating that sustainability competency development is not merely cognitive but deeply psychological. Students depleted by burnout are less likely to develop the systems thinking competency underlying sustainability-oriented action, while psychologically thriving students are better positioned to develop it. This bridges sustainability education theory, positive psychology, and entrepreneurial cognition in ways directly relevant to SDG 3, SDG 4, and SDG 8 [1,4,18]—and to the

broader goal of cultivating sustainability-oriented entrepreneurs, as articulated by Shepherd and Patzelt [18].

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Informed Consent Statement: Informed consent was obtained electronically from all subjects involved in the study. Before accessing the questionnaire, participants were presented with an information page describing the aims of the research, the anonymous and confidential nature of their participation, the voluntary character of their involvement, and their right to discontinue the survey at any time without penalty.

Data Availability Statement: The data supporting the findings of this study consist of self-reported survey responses on students' mental wellbeing, burnout, and related psychological constructs in specific institutional contexts. Due to the sensitivity of mental health information and the potential risk of indirect re-identification of individual participants, the full dataset is not publicly available without restrictions. However, an anonymous research record has been deposited in Zenodo. In addition, a suitably anonymized dataset can be made available from the corresponding author upon reasonable request for legitimate scientific purposes and subject to an agreement that participants' confidentiality will be preserved and no re-identification attempts will be made.

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