Factors Associated with Entrepreneurial Intention among Engineering Students in Chile: Cognitive Flexibility, Polychronicity, and Effectuation

Ruben Vega-Valenzuela, Universidad Andres Bello

Master in Industrial Engineering from the Andrés Bello University, Public Administrator from the University of Chile. He has three diplomas in the areas of operations management, project management and managerial management. Likewise, he has certifications in ontological coaching and comprehensive facilitation of learning processes. He currently works as academic secretary and tenured professor at Universidad Andrés Bello, where he teaches undergraduate and graduate courses related to innovation and entrepreneurship at the Faculty of Engineering. His areas of interest in the research are the deployment and impact of competencies, personal resources and soft or vital skills for the achievement of individual and collective results, through self-leadership, collaboration and team leadership.

Prof. Maria Elena Truyol, Universidad Andres Bello

María Elena Truyol, Ph.D., is full professor and researcher of the Universidad Andrés Bello (UNAB). She graduated as a physics teacher (for middle and high school), physics (M.Sc.), and a Ph.D. in Physics at Universidad Nacional de Córdoba, Argentina. In 2013, she obtained a three-year postdoctoral position at the Universidade de Sao Paulo, Brazil. She focuses on educational research, physics education, problem solving, instructional material design, teacher training, and gender studies. She teaches undergraduate courses in environmental management, energy, and the fundamentals of industrial processes at the School of Engineering, UNAB. She currently coordinates the Educational and Academic Innovation Unit at the School of Engineering (UNAB). She is engaged in continuing teacher training in active learning methodologies at the three campuses of the School of Engineering (Concepción, Viña del Mar, and Santiago, Chile). She authored several manuscripts in the science education area, joined several research projects, participated in international conferences with oral presentations and keynote lectures, and served as a referee for journals, funding institutions, and associations.

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Abstract

Chile's entrepreneurial ecosystem thrives on policies, support networks, and university-industry collaboration. Fostering an entrepreneurial mindset in engineering students is vital for innovation and addressing challenges. From a curricular perspective, international findings indicate that strengthening capabilities such as flexible time management (polychronicity) and cognitive flexibility/adaptability contribute to the development of entrepreneurial intention and behavior, with direct implications for program design. Recent evidence also highlights the importance of integrating decision-making frameworks tailored to entrepreneurship under uncertainty—particularly effectuation—and their positive correlation with entrepreneurial intention. Effectuation is conceived as a higher-order construct comprising experimentation, affordable loss, pre-commitment with key stakeholders, and flexibility; its components—particularly experimentation—are positively associated with entrepreneurial intention, with prior evidence reporting comparable associations among students with higher openness and extraversion. The literature supports the role of cognitive flexibility and adaptability in addressing complex, high-uncertainty contexts, fostering the generation of novel solutions and more efficient decision-making, while also relating to temporal preferences such as polychronicity, which is the inclination to alternate and coordinate multiple tasks —a frequent feature of entrepreneurial practice. This study aims to characterize the cognitive, attitudinal, and behavioral dimensions associated with entrepreneurship among third-year engineering students across multiple programs, a stage at which they complete the final course in the institution’s Innovation and Entrepreneurship track. Using validated instruments, we assessed seven constructs: cognitive flexibility, cognitive adaptability, polychronicity, entrepreneurial intention, openness to experience, extraversion, and experimentation. Preliminary results indicate that components associated with effectuation (experimentation and flexibility) show the strongest associations with entrepreneurial intention, whereas personality-related dimensions (openness and extraversion) display positive but smaller correlations. In summary, this descriptive-correlational study provides actionable insights for curricular improvement, recommending the prioritization of learning experiences that strengthen cognitive adaptability, flexible time management, and effective decision-making. These results would guide instructional decisions aimed at tailoring training for entrepreneurship in uncertain environments, improving knowledge transfer to the ecosystem, and informing efforts to support technology-based ventures. In doing so, they would provide an empirical foundation to inform efforts to align university education with the entrepreneurial mindset demanded by technological development in Chile and across the region. In addition, this work is expected to serve as a baseline for subsequent studies (e.g., comparisons with Chilean founders and multivariate models) that contribute to sustainable entrepreneurial ecosystems within higher education.

Keywords: Entrepreneurial mindset, Engineering students, Polychronicity, Effectuation, Entrepreneurial intention, Entrepreneurship education

Introduction

The entrepreneurial mindset has become a critical competency in the training of engineers in contexts characterized by high uncertainty, rapid technological change, and constant market transformation [1], [2]. In these environments, value creation increasingly depends on individuals' ability to recognize emerging opportunities, reconfigure limited resources, and act adaptively in the face of incomplete information [3], [4]. Consequently, entrepreneurship education has taken on a strategic role in engineering programs aimed at preparing students for nonlinear and dynamic career paths [5].

Although the literature recognizes a close relationship between entrepreneurial mindset and entrepreneurial intention, both constructs represent conceptually distinct phenomena. The entrepreneurial mindset is understood as a developable constellation of cognitive, emotional, and behavioral capabilities that enable action under uncertainty [2], while entrepreneurial intention corresponds to a specific mental state that reflects the deliberate decision to create a new venture [6], [7]. From this perspective, the mindset acts as a precursor to a more robust and persistent intention, whereas an intention formed without an adequate cognitive foundation tends to be fragile in the face of ambiguity and negative feedback [8].

Recent research documents significant gaps between students' cognitive dispositions in entrepreneurship programs and the reasoning patterns observed in active founders of technological ventures [9], [10]. These gaps suggest that entrepreneurial education has emphasized declarative content and normative tools, without sufficiently addressing the cognitive and temporal mechanisms that structure decision-making under radical uncertainty. In this context, a theoretical integration is needed to explain how individuals process cognitive complexity, manage simultaneous temporal demands, and adopt action logics that are coherent with environments where prediction is limited and control emerges through action [11], [12].

Literature converges around three key conceptual domains. First, cognitive flexibility and adaptability enable the reorganization of mental schemas and the adjustment of decisions in response to emerging contingencies, which are fundamental in entrepreneurial environments characterized by poorly structured problems [11], [13]. Second, policronicity — as a dispositional temporal preference — facilitates the alignment between individual capacities and the simultaneous demands of entrepreneurial vocation [14], [15], [12]. Third, the logic of effectuation explains how entrepreneurs act under radical uncertainty through iterative experimentation and the use of available means, showing consistent associations with entrepreneurial intention in educational contexts [4], [16]–[18].

Together, these arguments suggest that entrepreneurial intention in engineering students emerges as the result of a coherent configuration of cognitive processes, temporal preferences, and decision-making logics, rather than as a direct consequence of isolated traits. In this framework, the present study empirically examines entrepreneurial intention as a cognitive–temporal–decision-making phenomenon, analyzing in an integrated manner cognitive flexibility and adaptability, policronicity, and the core components of effectual reasoning in third-year engineering students in Chile. Using a cross-sectional quantitative design and a descriptive–correlational approach, the study provides foundational empirical evidence that clarifies the cognitive architecture underlying the formation of entrepreneurial intention and offers guidance for curriculum design aimed at the deliberate development of capacities to decide and act under uncertainty.

Theoretical framework

Entrepreneurial intention as a central cognitive construct in engineering education

Entrepreneurial intention is widely acknowledged as one of the most significant cognitive predictors of entrepreneurial behavior [7], [8]. From a psychological perspective, entrepreneurial intention is defined as a conscious mental state that guides an individual's attention, experience, and actions toward the initiation of new ventures [6]. In this context, entrepreneurial activity seldom occurs spontaneously; instead, it results from deliberate processes involving opportunity assessment, resource evaluation, and risk analysis.

The Theory of Planned Behavior (TPB) stands as the prevalent framework for examining entrepreneurial intention, conceptualizing it as a function of attitude towards the behavior, subjective norm, and perceived behavioral control [7]. Within the domain of entrepreneurship, numerous studies have empirically validated the TPB, establishing entrepreneurial intention as the most consistent proximal antecedent of entrepreneurial action [8], [19]. In the context of higher education, and particularly within engineering disciplines, entrepreneurial intention has been extensively employed as an outcome measure to assess the influence of training programs centered on innovation and entrepreneurship [20].

Nevertheless, contemporary research indicates a persistent discrepancy between intention and action, particularly among student populations [9]. This discrepancy does not undermine the significance of entrepreneurial intention; rather, it suggests that not all intentions formed are equally resilient, persistent, or capable of being translated into actual behavior. In environments characterized by significant technological uncertainty, resource limitations, and non-linear career trajectories—conditions typical of modern engineering—the cultivation of enduring entrepreneurial intent appears to rely on specific cognitive and decision-making frameworks that extend beyond general positive attitudes [3], [21]. Therefore, the fundamental question for engineering education is not merely whether students develop entrepreneurial intent but rather what cognitive mechanisms ensure the durability and resilience of such intent.

Entrepreneurial mindset in engineering education

The interest in entrepreneurial mindset within the domain of engineering education has progressively increased over the past decade. This focus has been partly propelled by institutional initiatives aimed at embedding value creation as an integral educational objective, transcending the sole aim of establishing companies as an end in itself. Notably, the Kern Entrepreneurial Engineering Network (KEEN) has assumed a pivotal role in advocating the Entrepreneurial Minded Learning (EML) approach, which has gained widespread adoption in engineering curricula. This methodology conceptualizes entrepreneurship as a means to learn how to identify opportunities, establish meaningful connections, and generate value amid conditions of uncertainty [22], [23].

From this perspective, the entrepreneurial mindset is pedagogically operationalized through the so-called *3C* (*curiosity, connections*, *and value creation*), which have been widely adopted in engineering curricula to align technical learning outcomes with entrepreneurial skills [24]. Recent research in engineering education has begun to position the EML as an integrative pedagogical framework, compatible with approaches such as *design thinking* and *systems thinking*, highlighting its potential to structure experiential learning focused on action and iteration [25].

However, critical reviews indicate that while the EML offers comprehensive pedagogical guidance, it does not explicitly delineate the cognitive and decision-making mechanisms through which students cultivate a robust entrepreneurial intention [26], [5]. This observation underscores the necessity to formulate more precise theoretical frameworks that elucidate how students acquire the skills to think, decide, and act under conditions of uncertainty, particularly within technical disciplines such as engineering.

Entrepreneurial cognition and the metacognitive shift

The paradigm shift in the study of entrepreneurship has transitioned the emphasis from the characteristics of the entrepreneur to the cognitive processes involved in opportunity recognition and decision-making under conditions of uncertainty [27]. Entrepreneurial cognition pertains to the knowledge frameworks, schemas, and heuristics that facilitate the interpretation of incomplete and ambiguous information within contexts of value creation [3].

Nevertheless, in environments marked by significant variability and swift changes—such as technological entrepreneurship—static cognitive structures are inadequate. In this context, metacognition emerges as an essential element of the entrepreneurial mindset. Haynie et al. [11] present a model of entrepreneurial mindset as situated metacognition, wherein cognitive adaptability is defined as the capacity to monitor, regulate, and reconfigure one's own thought processes in response to evolving environmental feedback. This capacity enables individuals to evaluate the appropriateness of various mental frameworks and to modify decision-making strategies accordingly.

Furthermore, cognitive flexibility is characterized by the capacity to alter perspectives, relinquish cognitive fixations, and create alternative solutions when confronted with poorly structured problems [13]. In general, adaptability and flexibility constitute the cognitive basis that underpins behaviors commonly linked to an entrepreneurial mindset, including experimentation, problem redefinition, and iterative learning. These competencies are especially pertinent for engineering students, given that conventional education tends to emphasize well-defined problems and optimal solutions, which contrasts with the open and uncertain nature inherent in entrepreneurial endeavors.

Effectuation as a decision-making logic under uncertainty

The effectuation theory is one of the most influential frameworks for entrepreneurial decision-making under radical uncertainty [16], [4]. Unlike causal logic—based on predefined goals, prediction, and planning—effectuation relies on non-predictive control through available means, iterative experimentation, and acceptance of manageable losses.

Chandler et al. [17] empirically operationalized effectuation through dimensions such as experimentation, affordable loss, and flexibility, enabling its quantitative analysis. This operationalization is particularly relevant to engineering education, as it translates common pedagogical practices—prototyping, early validation, and iterative cycles—into a coherent theoretical framework [28].

Recent evidence indicates that elements of effectual reasoning, especially experimentation, are positively associated with entrepreneurial intentions by enhancing perceptions of control and feasibility under uncertainty [18]. Effectuation thus links cognition and action, complementing metacognitive skills with a tangible decision-making framework when prediction is limited.

Temporal orientation and polychronicity as mechanisms for vocational adjustment

Although entrepreneurship is inherently transient—entailing the concurrent handling of various tasks, roles, and horizons—the temporal aspect has been insufficiently explored in conventional models of entrepreneurial intention. Policronicity, characterized as the dispositional inclination towards engaging in multiple activities simultaneously, emerges as a pivotal concept in understanding the alignment between individual preferences and the structural demands of entrepreneurship [14].

From the perspective of *person–vocation fit*, Cox et al. [12] suggest that polychrony may serve as a mediator in the relationship between cognitive abilities—such as flexibility and adaptability—and entrepreneurial intention. When individuals perceive that their preferred time management approach aligns with the requirements of the entrepreneurial role, their inclination towards entrepreneurship is likely to be reinforced. This mediating effect is particularly pertinent to engineering students, as entrepreneurship necessitates the concurrent coordination of technical exploration, user validation, and network development, contrasting with the sequential or linear paradigms prevalent in many technical curricula.

Personality traits as amplifiers

Literature acknowledges that certain personality attributes, such as *openness to experience* and *extraversion*, are associated with entrepreneurial intent [29]. Openness correlates with exploration and tolerance of novelty, whereas extraversion facilitates social interaction and network mobilization. Nonetheless, contemporary research concurs that these traits primarily function as amplifiers rather than direct causative factors when examining more proximal cognitive and decision-making mechanisms; that is, when cognitive and decision-making processes directly related to entrepreneurial activity are incorporated into the analysis [18]. From an educational standpoint, this observation reinforces the emphasis on trainable skills, which aligns with the conceptualization of an entrepreneurial mindset as a set of developable competencies.

Gap and objectives of the study

The reviewed literature converges on the notion that entrepreneurial intention among engineering students can be comprehended as the outcome of an integrated configuration comprising: (1) cognitive–metacognitive abilities, such as flexibility and adaptability; (2) effective decision-making logics that facilitate action under conditions of uncertainty; and (3) temporal preferences aligned with the demands inherent to the entrepreneurial role, notably polychronicity. Nonetheless, significant gaps persist within engineering education research: firstly, these components are frequently examined in isolation, without a comprehensive analysis of their combined influence within a singular explanatory framework; secondly, there exists limited empirical evidence pertaining to the Chilean context, particularly among cohorts situated at a critical stage of the curriculum when students conclude their training in innovation and entrepreneurship.

In this context, the aim of this study is to characterize the cognitive, attitudinal, and behavioral dimensions associated with entrepreneurial intention among third-year engineering students in Chile. This will be done by evaluating, through validated instruments, cognitive flexibility and adaptability, polychrony, and components related to the logic of effectuation, in order to generate evidence applicable to curriculum redesign decisions and the strengthening of training experiences aimed at entrepreneurship in high-uncertainty environments.

Methodology

This quantitative study employs a cross-sectional survey methodology. This section delineates the research approach, data collection instruments, sampling procedures, and statistical techniques utilized for data analysis.

The sample comprised 497 undergraduate engineering students attending a private university in Chile. Participants were enrolled in programs across three departments: 41% from the Department of Industrial Engineering, 30.6% from the Department of Computer Science, and 28.4% from the Department of Earth Science. The ages of participants ranged from 19 to 42 years ($M = 22.47$, $SD = 3.22$); approximately half were between 19 and 21 years old (49.1%), 36.0% were between 22 and 24 years old, and 14.9% were aged 25 or older. Concerning work experience, 21.3% reported no experience, 12.7% had completed a professional internship, 48.9% were engaged in dependent employment, and 17.1% had experience with their own entrepreneurial ventures. Regarding family history of entrepreneurship, 64% indicated having at least one family member with entrepreneurial experience, 26.8% indicated no entrepreneurial history in the family, and 9.2% indicated they were unaware of this information.

Data were collected using a structured questionnaire comprising six validated scales pertaining to entrepreneurial intention and socio-cognitive dispositions. The instrument consisted of 29 Likert-type items, rated on a 5-point scale from 1 (strongly disagree) to 5 (strongly agree), along with a brief section on sociodemographic and academic background. *Entrepreneurial intention* was measured with five items from proposed in [19]. *Experimentation* was assessed with five items adapted from [18] and [30]. *Openness* and *extraversion* were each measured with four items taken from [18]. *Polychronicity* was measured with three positively worded items adapted from [12], and *cognitive flexibility-adaptability* with eight items from [12]. Confirmatory factor analyses supported the six-factor structure, and the scales showed internal consistency indices ranging from .57 to .92 for McDonald's ω and from .57 to .91 for Cronbach's α (see Table 1). Given that this is an exploratory first version of the instrument and some ω and α coefficients, particularly for *openness* and *polychronicity*, are relatively low, we expect to refine the scales and improve their psychometric properties in subsequent data collections. For polychronicity specifically, item-rest correlations were .36, .42, and .38 (all > .30; average interitem r = .32), indicating that the three items contributed comparably; the modest α reflects the scale's short length (three items) rather than a weak item, and future work will prioritize adding items over item removal.

Table 1. Scale reliability statistics (McDonald's ω and Cronbach's α).

Variable	N° items	ω	α
Entrepreneurial Intention	5	.92	.91
Experimentation	5	.82	.82
Openness	4	.65	.64
Polichronicity	3	.57	.57
Cognitive flexibility-adaptability	8	.81	.78
Extraversion	4	.82	.75

Faculty members distributed the questionnaire during class sessions, allowing students sufficient time to complete it. The process commenced with obtaining informed consent, providing assurances of confidentiality, and providing contact information for inquiries related to the research. The questionnaire was developed and disseminated through Microsoft Forms, with the collected data being anonymized and securely stored

All statistical analyses were conducted with IBM SPSS Statistics 29. We inspected variable distributions, checked for outliers, and evaluated univariate normality using skewness and kurtosis. We computed descriptive statistics (means, standard deviations, and 95% confidence intervals) and Pearson correlations among main constructs. To examine group differences, we performed independent t-tests (gender and coursework) and one-way ANOVAs for age, academic departments, and work experience. All tests used a .05 significance level with two-tailed p-values.

Results

The results are presented in steps to overview students' entrepreneurial mindset. First, descriptive stats and correlations describe levels and relations among variables. Next, group differences are examined, starting with demographics and academic factors, then experiential variables linked to entrepreneurial growth. Gender differences are analyzed first, followed by age groups and academic departments (Earth Sciences, Computer Science, Industrial Engineering). Lastly, differences based on work experience and entrepreneurship courses are shown to explore their relation to entrepreneurial intention and related cognitive and personality traits.
On a five-point scale, students reported scores above the midpoint on all six dimensions, indicating generally favorable profiles across the measures. As summarized in Table 2, the highest levels were observed for *cognitive flexibility-adaptability* (M = 4.19, SD = 0.47),

openness (M = 4.13, SD = 0.58) and *experimentation* (M = 4.12, SD = 0.59), suggesting frequent use of flexible cognitive strategies and effectual behaviors, as well as a generally open disposition. *Extraversion* also showed relatively high levels (M = 3.95, SD = 0.63), followed by *entrepreneurial intention* (M = 3.72, SD = 0.92). *Polychronicity* had the lowest mean (M = 3.34, SD = 0.69), indicating more moderate preferences for non-sequential time structuring and parallel role coordination.

Regarding distributional assumptions (Table 2), all variables showed negative skewness (ranging from −0.23 to −1.52), reflecting a tendency toward higher scores, and positive kurtosis (from 0.87 to 7.02), indicating moderately leptokurtic distributions, particularly for cognitive flexibility and experimentation. However, skewness values remained well below an absolute value of 2, and kurtosis estimates were at or below 7, ranges generally considered acceptable for treating variables as approximately normal in large samples. Given a sample size of about N = 497, these deviations from normality are unlikely to substantially bias subsequent analyses, supporting the use of parametric procedures such as one-way ANOVA and Pearson correlations.

Table 2. Descriptive statistics, skewness, and kurtosis of the study variables.

	Mean	Std. Deviation	Skewness	Kurtosis
Entrepreneurial Intention	3.715	0.924	-0.787	0.872
Experimentation	4.124	0.594	-1.524	5.786
Openness	4.133	0.582	-1.040	3.385
Polichronicity	3.343	0.691	-0.234	1.977
Cognitive flexibility-adaptability	4.187	0.470	-1.343	7.020
Extraversion	3.949	0.627	-0.893	3.074

Bivariate Pearson correlations among the study variables are presented in Table 3. Entrepreneurial intention showed its strongest association with *experimentation* (r = .593, p < .001), followed by *cognitive flexibility–adaptability* (r = .381, p < .001) and *polychronicity* (r = .395, p < .001), with more modest but still significant correlations with *openness* (r = .325, p < .001) and *extraversion* (r = .292, p < .001). *Experimentation* was highly correlated with *cognitive flexibility–adaptability* (r = .686, p < .001) and *openness* (r = .564, p < .001), and also showed positive correlations with *polychronicity* (r = .375, p < .001) and *extraversion* (r = .438, p < .001). The remaining constructs were moderately intercorrelated, with coefficients ranging from .305 to .653 (all p < .001). All correlations remained below .70, suggesting that the constructs, although related, are not redundant.

We conducted independent samples t-tests to examine gender differences in the entrepreneurial mindset variables. Compared with women (n = 111), men (n = 386) reported higher *entrepreneurial intention* (M = 3.77, SD = 0.90 vs. M = 3.53, SD = 1.00), t(495) = 2.41, p = .016, higher *experimentation* (M = 4.17, SD = 0.56 vs. M = 3.91, SD = 0.78), t(495) = 3.13, p = .002, higher *cognitive flexibility-adaptability* (M = 4.22, SD = 0.47 vs. M = 4.05, SD = 0.69), t(495) = 2.60, p = .010, and higher *extraversion* (M = 4.01, SD = 0.60 vs. M = 3.75, SD = 0.69), t(495) = 3.89, p < .001. In contrast, differences in *openness*, t(495) = 0.32, p = .748, and *polychronicity*, t(495) = 0.54, p = .591, were not statistically significant. Effect sizes were generally small to moderate across the variables. Specifically, Cohen's *d* indicated small effects for Entrepreneurial Intention (*d* = 0.26) and Cognitive (*d* = 0.28), a small-to-moderate effect for Experimentation (*d* = 0.34), and a moderate effect for Extraversion (*d* = 0.42). In contrast, Openness (*d* = 0.04) and Polichronicity (*d* = 0.06) showed negligible effect sizes, suggesting minimal practical differences between groups for these variables. Overall, the largest group difference was observed in Extraversion, while the remaining effects were modest in magnitude.

Table 3. Pearson correlation matrix of the study constructs.

	Entrepreneurial Intention	Experimentation	Openness	Polichronicity	Cognitive flexibility-adaptability	Extraversion
Entrepreneurial Intention	— —					
Experimentation	0.593*** < .001	— —				
Openness	0.325*** < .001	0.564*** < .001	— —			
Polichronicity	0.398*** < .001	0.375*** < .001	0.305*** < .001	— —		
Cognitive flexibility-adaptability	0.381*** < .001	0.686*** < .001	0.653*** < .001	0.428*** < .001	— —	
Extraversion	0.292*** < .001	0.438*** < .001	0.439*** < .001	0.333*** < .001	0.504*** < .001	— —

Table 4. Independent-Samples t-Tests for Gender Differences in Entrepreneurial Mindset Variables

	Independent Samples T-Test			***Men***		***Women***	
	t	***df***	***p***	***Mean***	***SD***	***Mean***	***SD***
Entrepreneurial Intention	2.411	495	.016	3.768	0.896	3.530	0.997
Experimentation	3.129	495	.002	4.168	0.560	3.969	0.680
Openness	0.322	495	.748	4.137	0.585	4.117	0.573
Polichronicity	0.537	495	.591	3.352	0.685	3.312	0.714
Cognitive flexibility-adaptability	2.601	495	.010	4.216	0.465	4.085	0.475
Extraversion	3.885	495	< .001	4.006	0.597	3.748	0.687

We also performed a series of one-way ANOVA tests to determine if the entrepreneurial mindset variables varied among three age groups: 19-21 years, 22-24 years, and 25 years or older. The analyses showed that the mean levels of all the variables of interest were very similar across age groups, and none of the overall tests reached statistical significance at the .05 level. For example, the F statistics were 1.25 ($p = .288$) for *entrepreneurial intention*, 0.20 ($p = .821$) for *experimentation*, 2.49 ($p = .084$) for *openness*, 0.67 ($p = .513$) for *polychronicity*, 1.33 ($p = .265$) for *cognitive flexibility-adaptability*, and 1.31 ($p = .272$) for extraversion. These results suggest that, within this sample, the studied dimensions of entrepreneurial mindset are relatively stable across the age range, so age was not treated as a key differentiating factor in subsequent analyses.

One-way ANOVAs comparing the three departments (Earth Sciences, Computer Science, Industrial Engineering) revealed significant differences for *entrepreneurial intention*, $F(2, 494) = 8.04$, $p < .001$, $\eta^2 = .032$; *experimentation*, $F(2, 494) = 6.19$, $p = .002$, $\eta^2 = .024$; *polychronicity,* $F(2, 494) = 5.96$, $p = .003$, $\eta^2 = .024$; and *cognitive flexibility-adaptability*, $F(2, 494) = 4.48$, $p = .012$, $\eta^2 = .018$. In each case, Industrial Engineering students scored highest (Table 5), except for polychronicity, where Earth Sciences led. No significant differences were found for openness ($p = .488$) or extraversion ($p = .079$). All effect sizes were small ($\eta^2 = .018–.032$), indicating that departmental affiliation accounts for a limited proportion of variance in these dimensions.

Table 5. One-Way ANOVA Results for Differences in Entrepreneurial Mindset Variables Across Academic Departments

		Sum of Squares	**gl**	**Mean Square**	**F**	**Sig.**
Entrepreneurial Intention	Between groups	13.331	2	6.665	8.035	<.001
	Within groups	409.766	494	0.829		
	Total	423.097	496			
Experimentation	Between groups	4.282	2	2.141	6.193	0.002
	Within groups	170.812	494	0.346		
	Total	175.095	496			
Openness	Between groups	0.488	2	0.244	0.719	0.488
	Within groups	167.498	494	0.339		
	Total	167.985	496			
Polichronicity	Between groups	5.582	2	2.791	5.959	0.003
	Within groups	231.368	494	0.468		
	Total	236.95	496			
Cognitive flexibility-adaptability	Between groups	1.95	2	0.975	4.479	0.012
	Within groups	107.51	494	0.218		
	Total	109.459	496			
Extraversion	Between groups	1.996	2	0.998	2.553	0.079
	Within groups	193.071	494	0.391		
	Total	195.067	496			

A one-way ANOVA revealed significant differences across work experience groups (entrepreneurship, salaried job, internship, no experience) for all six variables (Table 6). Students with entrepreneurial experience consistently scored highest, followed by those with salaried jobs and internships, while students without work experience scored lowest. Entrepreneurial intention showed the largest effect, $F(3, 493) = 16.01$, $p < .001$, $\eta^2 = .089$ (medium), suggesting that work experience accounts for a meaningful share of variance in this construct. The remaining variables were also significant ($p \leq .020$) but yielded small effect sizes ($\eta^2 = .020–.054$), indicating that the association between work experience and cognitive, temporal, and personality-related dimensions, while consistent in direction, is comparatively modest.

Table 6. One-Way ANOVA Results for Differences in Entrepreneurial Mindset Variables Across Students' Work Experience

		Sum of Squares	**gl**	**Mean Square**	**F**	**Sig.**
Entrepreneurial Intention	Between groups	37.567	3	12.522	16.013	<.001
	Within groups	385.53	493	0.782		
	Total	423.097	496			
Experimentation	Between groups	9.431	3	3.144	9.355	<.001
	Within groups	165.664	493	0.336		
	Total	175.095	496			
Openness	Between groups	3.322	3	1.107	3.316	0.02
	Within groups	164.663	493	0.334		
	Total	167.985	496			
Polichronicity	Between groups	5.681	3	1.894	4.037	0.007
	Within groups	231.269	493	0.469		
	Total	236.95	496			
Cognitive flexibility-adaptability	Between groups	4.957	3	1.652	7.796	<.001
	Within groups	104.502	493	0.212		
	Total	109.459	496			
Extraversion	Between groups	6.261	3	2.087	5.449	0.001
	Within groups	188.806	493	0.383		
	Total	195.067	496			

One-way ANOVAs were conducted to compare students based on whether they reported a family history of entrepreneurship (yes: N = 318; no: N = 133; I don't know: N = 46). Results ar presented in Table 7. Statistically significant differences were observed for entrepreneurial intention, $F(2, 494) = 6.997$, $p = .001$, $\eta^2 = .028$, and polychronicity, $F(2, 494) = 4.736$, $p = .009$, $\eta^2 = .019$, both reflecting small effect sizes. Students who reported a family history of entrepreneurship exhibited higher entrepreneurial intention ($M = 3.820$, $SD = 0.895$) and polychronicity ($M = 3.414$, $SD = 0.691$) compared to those without such background ($M = 3.468$, $SD = 1.012$ and $M = 3.208$, $SD = 0.716$, respectively). No significant differences were found for experimentation ($p = .075$), openness ($p = .167$), cognitive flexibility ($p = .321$), or extraversion ($p = .061$), all of which yielded negligible effect sizes ($\eta^2 \leq .011$). These results suggest that family exposure to entrepreneurship is selectively associated with motivational and temporal dimensions rather than with cognitive or personality-related traits.

Discussion

The results show that third-year engineering students (N=497) exhibit favorable cognitive abilities—cognitive flexibility (M=4.19), openness (M=4.13), and experimentation (M=4.12)—but a significantly lower entrepreneurial intention (M=3.72). This 13.4 percentage-point gap between available cognitive capacity and expressed entrepreneurial intention constitutes the central pedagogical finding: students can undertake entrepreneurial activities but do not necessarily intend to. Critically, policronicity (a temporal orientation favoring the nonsequential and overlapping coordination of activities and roles) records the lowest average (M=3.34), making it a potentially relevant target for curricular intervention; however, this interpretation warrants caution given the low internal consistency of the polychronicity scale ($\alpha = .57$) and the small effect sizes observed across group comparisons ($\eta^2 = .003–.032$).

Table 7. One-Way ANOVA Results for Differences in Entrepreneurial Mindset Variables Across Reported Family History of Entrepreneurship

		Sum of Squares	**gl**	**Mean Square**	**F**	**Sig.**
Entrepreneurial Intention	Between groups	11.656	2	5.828	6.997	0.001
	Within groups	411.441	494	0.833		
	Total	423.097	496			
Experimentation	Between groups	1.822	2	0.911	2.598	0.075
	Within groups	173.272	494	0.351		
	Total	175.095	496			
Openness	Between groups	1.212	2	0.606	1.796	0.167
	Within groups	166.773	494	0.338		
	Total	167.985	496			
Polichronicity	Between groups	4.458	2	2.229	4.736	0.009
	Within groups	232.492	494	0.471		
	Total	236.95	496			
Cognitive flexibility-adaptability	Between groups	0.503	2	0.251	1.14	0.321
	Within groups	108.957	494	0.221		
	Total	109.459	496			
Extraversion	Between groups	2.197	2	1.099	2.814	0.061
	Within groups	192.869	494	0.39		
	Total	195.067	496			

The ordering of variables by the strength of correlation with entrepreneurial intention shows that experimentation (r=.593) is more strongly associated than cognitive flexibility-adaptability (r=.381). This has direct pedagogical implications: it is not enough to teach divergent thinking (cognitive flexibility-adaptability); students must do so. The high correlation between experimentation and cognitive flexibility-adaptability (r=.686) suggests a reflective mechanism in which action may play a facilitating role in the strengthening of cognitive skills. For educators, this implies prioritizing authentic entrepreneurial experiences over purely formative simulations.

Primacy of effectuation over dispositional traits

The most significant discovery of this study contests the prevailing paradigm in entrepreneurship research that concentrates on individual traits. While traditional literature [29], [31] has emphasized dispositional characteristics such as locus of control, risk propensity, and need for achievement as primary indicators of entrepreneurial intent, our data derived from a sample of 497 engineering students in Chile demonstrate that experimentation, associated with effectuation, is more strongly associated with the intention to establish a business than openness to experience or extraversion.

This pattern aligns with the findings of Wang et al. [18], who indicate that experimentation, conceptualized as a multidimensional construct encompassing experimentation, affordable loss, pre-commitment, and flexibility, is significantly associated with entrepreneurial intention ($\beta = 0.544$, $p < 0.001$, $R^2 = 0.474$). Nonetheless, the primary contribution of this study lies in elucidating the most proximal mechanism—that is, the processes closest to entrepreneurial action: in conditions characterized by radical uncertainty, inherent in technological entrepreneurship, the willingness to engage in iterative experimentation shows a more direct association with entrepreneurial intention than generic dispositional traits.

Theoretically, this aligns with Sarasvathy's distinctions [16], [4] between *causality*—entailing prediction and comprehensive planning—and *effectuation,* characterized by iterative actions utilizing available means. Within educational settings that feature limited resources and rapid feedback cycles, experimentation appears to operate as a particularly pertinent correlate: a student exhibiting high openness but low willingness to endeavor incomplete ideas may remain in a state of deliberation, whereas a student possessing moderate openness yet demonstrating high experimentation accumulates feedback that facilitates the consolidation of intention [17]. From an educational perspective, it is noteworthy that, rather than concentrating solely on 'developing traits,' these findings indicate that the educational benefit may be enhanced when curriculum design emphasizes opportunities for iterative experimentation under uncertainty, thereby enabling students with diverse profiles to cultivate effective decision-making skills [5], [10].

Cognitive Flexibility and Polychronicity as Complementary Factors to Effectuation

The findings of this investigation, which aims to identify factors associated with entrepreneurial intention among engineering students in Chile, demonstrate a pattern consistent with the title and the proposed conceptual framework: entrepreneurial intention is correlated both with cognitive dispositions and with temporal preferences, and particularly with action behaviors under conditions of uncertainty [6], [7], [8], [12].

In particular, experimentation—considered here as a representative dimension of effectuation—shows the strongest association with entrepreneurial intention ($r = .593$, $p < .001$), suggesting that the willingness to learn through trial and adjustment, to iterate with early feedback, and to move forward with incomplete information shows a proximal association with entrepreneurial intention [16], [4], [17], [18]. Likewise, polychronicity is positively and substantially associated with entrepreneurial intention ($r = .398$, $p < .001$), which is consistent with the idea of aligning individual temporal preferences with the demands of the entrepreneurial role, which often involves the parallel coordination of interrelated activities and roles [14], [15], [12]. Finally, cognitive flexibility-adaptability also shows a positive correlation with entrepreneurial intention ($r = .381$, $p < .001$), indicating that the ability to reframe problems, switch interpretive frameworks, and adjust strategies in response to emerging contingencies could facilitate the transition from a general entrepreneurial orientation to a more defined intention [11], [13], [3]. Given the marginal reliability of the polychronicity scale, associations involving polychronicity are reported as exploratory.

Collectively, these associations imply particular curricular implications: instead of concentrating exclusively on general attitudes, educational programs might emphasize experiential learning that explicitly fosters iterative experimentation (such as through rapid prototyping and early validation), alongside dynamics that necessitate polychronous coordination of activities and the intentional cultivation of cognitive flexibility. This approach aims to reinforce the mechanisms most closely associated with entrepreneurial intention [20], [5].

Gender: behavioral gap

The observed gender differences indicate a disparity primarily in entrepreneurial dispositions and behaviors, rather than in traits associated with openness to change or preferences for a non-sequential temporal structuring. Compared to women, men reported higher scores in entrepreneurial intention ($M = 3.77$ vs. 3.53; $p = .016$) and experimentation ($M = 4.17$ vs. 3.97; $p = .002$). Additionally, they demonstrated higher levels of cognitive flexibility–adaptability ($M = 4.22$ vs. 4.09; $p = .010$) and extraversion ($M = 4.01$ vs. 3.75; $p < .001$), indicating a profile more inclined toward exploration, adaptation, and social engagement. Conversely, no significant differences were observed in openness ($p = .748$) or policronicity ($p = .591$). Notably, all significant differences corresponded to small effect sizes (Cohen's $d = 0.035$–0.418), indicating that while statistically detectable, the practical magnitude of these gender gaps is modest.

This pattern challenges narratives that attribute gender gaps, in particular, to lower cognitive abilities [33], [34]. Instead, it is consistent with what McMullen & Shepherd [3] refer to as "behavioral inhibition mediated by perceived viability": female students possess comparable abilities but demonstrate a lower willingness to experiment under conditions of uncertainty, potentially linked to differentiated perceptions of social risk and the perceived alignment between femininity and entrepreneurial roles [12], [35].

From a developmental perspective, these findings underscore the significance of designing entrepreneurial experiences that diminish the social costs associated with failure—such as through the implementation of explicit mechanisms for psychological safety, formative feedback, and the normalization of failure as an inherent component of the learning process—thus encouraging participation in experimental behaviors, particularly in contexts where performance is observable and assessable by others. Concerning interventions, the emphasis should not be on 'correcting abilities,' but rather on alleviating contextual frictions that impede the translation of abilities into action: (1) normalizing rapid experimentation as a form of learning, (2) establishing psychologically safe environments where failure is regarded as valuable experimental data, and (3) integrating mentoring and female role models with comparable visibility [2], [10], [36].

Previous experience as a multicomponent catalyst

Students possessing their own entrepreneurial experience demonstrate higher scores across all assessed dimensions — including intention, experimentation, cognitive flexibility, adaptability, polychrony, openness, and extraversion. However, the magnitude of these differences varied: only entrepreneurial intention reached a medium effect size ($\eta^2 = .089$), while the remaining dimensions exhibited small effects ($\eta^2 = .010$–$.046$). Thus, although direct experience is associated with a more comprehensive cognitive, temporal, and dispositional profile than mere intention, the strength of these associations is generally modest.

This aligns with the theory of situated learning [37] and supports the proposition that cognitive adaptability can be cultivated through experiential learning in contexts characterized by radical uncertainty. Entrepreneurial experience provides authentic feedback cycles, non-simulated uncertainty, and necessitates strategic reconfiguration [11].

In the context of instructional design, these findings endorse the transition from predominantly classroom-centric approaches to more immersive experiential methodologies: prototyping with authentic validation (as opposed to simulated), mentoring involving active entrepreneurs exposed to actual *pivots,* and projects operating under real resource uncertainties [5], [36].

Family background: regulatory permission rather than cognitive advantage

Family entrepreneurial backgrounds are associated with limited effects on the analyzed outcomes: entrepreneurial intention ($p=.001$) and polychronicity ($p=.009$), but do not show significant effects on experimentation ($p=.075$), cognitive flexibility-adaptability ($p=.321$), or openness ($p=.167$). These results could suggest that entrepreneurial family environments tend to transmit normative permission and cognitive availability toward entrepreneurship, rather than a superior cognitive capacity. Consistently, 36% of students without entrepreneurial family backgrounds exhibit similar levels of cognitive abilities but lack social normalization of entrepreneurship. From an institutional perspective, these findings indicate that educational institutions can play a compensatory role, replacing family normalization through training strategies that make entrepreneurship a legitimate and visible option for all students.

Differences across academic departments: the influence of curriculum structure

A consistent interdepartmental variation is observed: Industrial Engineering shows higher levels than Computer Science and Earth Sciences in entrepreneurial intention, experimentation, and cognitive flexibility-adaptability, with no differences in openness or extraversion. This pattern is consistent with curriculum structure contributing to these differences, although self-selection into programs and tracks cannot be ruled out given the cross-sectional design.

From an interpretive standpoint, Industrial Engineering, which emphasizes optimizing complex systems, could more systematically incorporate teaching methods focused on iterative design and rapid prototyping. Meanwhile, Computer Science and Earth Sciences, usually based on detailed requirement specifications, often prioritize finding optimal solutions rather than experimenting [1].

Overall, the findings are consistent with the idea that an entrepreneurial mindset may be shaped by curriculum design. The systematic variation in entrepreneurial intention across cohorts, combined with comparable levels of openness and extraversion, is consistent with pedagogical experiences contributing to intention, though self-selection cannot be ruled out. This supports exploring interdepartmental redesign toward models that incorporate pedagogies of iterative experimentation [5], [18].

Likewise, the results indicate that entrepreneurial intention in engineering students is better explained by considering proximate decision-making and behavioral mechanisms (such as experimentation or effectuation) and their temporal adjustment (polychronicity), rather than focusing solely on general dispositional traits.

In summary, the study reveals that entrepreneurial mindset is sensitive to both curriculum design and direct experience, while remaining relatively unchanged in response to variables such as age or sociodemographic background. The observed differences seem to be mediated by mechanisms such as gender-related behavioral inhibition, unequal access to work experiences, and the temporal organization of training programs. Overall, the data suggest the need for a pedagogical reconfiguration that prioritizes models where action and experimentation precede conceptual development.

Limitations and future directions

This study is descriptive-correlational; therefore, it does not allow for causal inferences. Although the data suggest that experimentation is more strongly associated with entrepreneurial intention than with personality traits, experimental designs (e.g., deliberate implementation of effectuation pedagogies with control groups) are needed to evaluate causal relationships. Additionally, the reliability of policronicity was low ($\omega = 0.57$, $\alpha = 0.57$), which limits confidence in specific conclusions about this construct and suggests the need to refine items and revalidate the scale. Finally, because the design is cross-sectional and lacks pre-enrolment measures, between-department differences cannot be separated from self-selection: students choosing Industrial Engineering or the Innovation and Entrepreneurship track may have entered with stronger entrepreneurial dispositions or prior exposure to entrepreneurial role models.

Finally, future research could focus on: (1) the longitudinal tracking of students transitioning toward entrepreneurial action; (2) comparison with active founders to strengthen nomological validation; (3) the use of multivariate analyses (e.g., structural equation models) to examine the proposed mediational relationships; and (4) the implementation of experimental interventions to assess whether pedagogies based on enactment generate changes in entrepreneurial intention or if they simply covary with belonging to heterogeneous groups.

Conclusion

Iterative experimentation showed a stronger association with entrepreneurial intention ($r = .593$) than personality traits such as openness ($r = .325$) or extraversion ($r = .292$). In a representative sample of third-year students, participants displayed substantial cognitive resources—cognitive flexibility, openness, and a propensity for experimentation—yet their stated entrepreneurial intentions were lower than those resources might suggest. This gap conveys a key pedagogical message: latent capacity does not automatically translate into entrepreneurial inclination.

The strongest association we observed—iterative experimentation with entrepreneurial intention—exceeds those of stable traits such as openness or extraversion. Under the uncertainty typical of technological entrepreneurship, the willingness to act and learn through trial and error appears more closely tied to entrepreneurial intention than dispositional profiles, suggesting that an entrepreneurial mindset may be better understood as tied to the systematic practice of action.

From this perspective, effectuation acquires renewed pedagogical relevance: practices that facilitate early experimentation, leverage available resources, and incorporate rapid feedback may create conditions associated with entrepreneurial intent across diverse student populations.

Similarly, dimensions such as polychrony and cognitive flexibility exhibit substantial correlations with entrepreneurial intention, indicating that temporal preferences and cognitive adaptability are also influential. These findings underscore the importance of incorporating into the curriculum experiences that involve coordinating multiple tasks, adapting strategies, and making decisions within dynamic environments.

The observed differences between academic departments further substantiate this interpretation. Industrial Engineering, in comparison to Computer Science and Earth Sciences, demonstrates elevated levels of intentionality, experimentation, and cognitive flexibility and adaptability. Given that no disparities were identified in fundamental personality traits, these variations are consistent with curricular context contributing to entrepreneurial dispositions, although self-selection cannot be ruled out (see Limitations). These findings suggest that pedagogical context is worth attending to as a potential correlate of entrepreneurial dispositions. As this is a cross-sectional, correlational design, these patterns describe associations and do not support causal claims.

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