2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Paper ID #51083

Developing Persuasion and Support-Network Competence in Engineering Students: Evidence from a Fully Online Entrepreneurship Course

Barbara Munoz-Vallejos, Universidad Andres Bello

Bárbara Estefanía Muñoz Vallejos, M.Sc., is an Assistant Professor and faculty member at the School of Engineering, Universidad Andrés Bello (UNAB), Chile. She holds a degree in Psychology and a Bachelor's in Psychology from Universidad del Desarrollo (2008). Additionally, she earned a Master's degree in Curriculum Development and Educational Projects from Universidad Andrés Bello (2019–2021). She has also completed several postgraduate diplomas in leadership, educational innovation, change management, educational assessment, and the pedagogy of well-being. Her professional focus lies in educational innovation, creativity development, leadership, teamwork, psychosocial risk prevention, and personal entrepreneurial competencies. Since 2015, she has served as an undergraduate and graduate instructor at the School of Engineering at UNAB, teaching courses related to innovation, entrepreneurship, creativity, leadership, and change management. She also serves as the coordinator of the Innovation and Entrepreneurship Academy at the School of Engineering. She is a consultant and director of a training organization specializing in educational innovation, entrepreneurial skills, and organizational well-being. With over ten years of experience, she designs and facilitates workshops on leadership, teamwork, creativity, and innovation. She is also an ambassador for the Endowment Program at Universidad Andrés Bello and was awarded an immersive entrepreneurship experience in Boston in 2024.

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.

Developing Persuasion and Support-Network Competence in Engineering Students: Evidence from a Fully Online Entrepreneurship Course

Abstract

In engineering education, developing entrepreneurial competencies is essential for preparing professionals to thrive in dynamic, uncertain, and demanding environments. Among these competencies, persuasive communication and the cultivation of support networks are particularly salient because they expand opportunities, mobilize resources, influence key stakeholders, and create collaborative contexts that accelerate innovation. Yet evidence on how these capabilities develop in fully online learning environments—especially in degree-completion programs serving working adults—remains limited. This study analyzes the development of persuasion and support-network competence among engineering students enrolled in Innovation and Entrepreneurship Workshop I, a fully online course in a degree-completion program at a private engineering school in Chile. The methodological design is quantitative, descriptive, and non-experimental, and it triangulates three complementary sources of evidence: (i) a validated Personal Entrepreneurial Competencies (PECs) questionnaire administered as a pre- and post-test to capture changes in self-perceived competence; (ii) an authentic deliverable scored with an analytic rubric assessing intention, relevance, and classification of networking actions to capture observable performance; and (iii) the overall course grade as an indicator of convergent validity with the rubric-based assessment. The sample comprised 44 participants. Pre-test self-perceptions were moderate to high across opportunity seeking, persuasion/support networks, and self-confidence; however, self-reported levels (pre and post) were not significantly associated with authentic task performance, indicating a gap between perception and action. Individual gains (Δ = post − pre) did not follow a monotonic pattern across performance levels, suggesting that perceived improvement does not necessarily translate into higher-quality deliverables. Pre–post analyses revealed a differentiated pattern: opportunity seeking improved significantly, whereas persuasion/support networks showed no meaningful change, and self-confidence varied only marginally. The strong convergence between the rubric and the overall course grade supports the internal coherence of the performance assessment and reinforces the interpretation of the perception–performance mismatch. Overall, these findings yield actionable guidance for fully online entrepreneurship courses serving working adults: prioritize authentic tasks with observable evidence, employ dual assessment that combines self-report with performance, and target scaffolding and feedback toward persuasion- and networking-related behaviors through iterative practice cycles and structured interaction with external stakeholders.

Keywords: Entrepreneurship education, Engineering education, Online learning, Persuasion, Networking

Introduction

In a context of accelerated technological transformation and increasing complexity in innovation ecosystems, engineering education faces the challenge of preparing professionals capable of creating value, acting under uncertainty, and collaborating effectively with diverse stakeholders, beyond strictly technical expertise [1], [2]. In response to these demands, entrepreneurship education has evolved from approaches primarily focused on entrepreneurial intention to models aimed at developing transferable and observable entrepreneurial skills, relevant for both independent entrepreneurship and intrapreneurship and organizational innovation [3], [4].

Recent empirical evidence indicates that entrepreneurial education is associated with positive outcomes in variables related to entrepreneurial action; however, these effects largely depend on the pedagogical design, the intensity of the experience, and the assessment approaches used [4], [5].

In this scenario, there has been a particular emphasis on behavioral and social skills, such as influencing, persuading, and building networks, especially in programs aimed at developing an entrepreneurial mindset in engineering students [1]. However, a persistent limitation in entrepreneurial education research is the reliance on measurements based solely on self-perception, which makes it difficult to estimate the extent to which declared competencies translate into actual performance [6]. Several reviews warn that, in the absence of evidence of action, conclusions about skill development may overestimate achievements or fail to adequately capture the gap between self-perceived performance and actual behavior in authentic situations and real-world contexts [6], [7].

This difficulty is heightened in fully online environments, where interaction dynamics, social negotiation, and exposure to authentic relational situations differ from face-to-face modalities. Recent studies emphasize that while online education expands access and flexibility—especially for adult working students—it also presents specific challenges for developing complex relational skills, which require deliberate practice, social feedback, and tasks with a high degree of professional realism [8]. Consequently, it becomes necessary to design learning and assessment experiences that allow for the observation of evidence of influence, persuasion, and network building in concrete products and performances, beyond statements of intent or self-assessments.

This research analyzes the development of persuasion skills and the building of support networks in engineering students enrolled in a 100% online program aimed at working adults, understanding networking as a strategic behavior oriented toward mobilizing relational resources. It focuses on the Personal Entrepreneurial Competence (PEC) related to these skills, and also incorporates opportunity detection and self-confidence to explore their functional interactions as potentially enabling competencies—though not sufficient on their own—for effective performance in network contexts.

Through triangulation of self-perception, rubric-based evaluation, and analysis of deliverables, the study examines the gap between perception and performance, and

proposes pedagogical guidelines for designing learning experiences that strengthen entrepreneurial social capital and the effective mobilization of support in virtual environments. Overall, it provides empirical evidence on the development of these competencies in online programs for professionals, contributing to aligning educational objectives, tasks, and assessment in engineering education.

Related works

Specialized literature agrees that entrepreneurship and innovation training in engineering education requires moving beyond approaches focused solely on technical mastery and incorporating behavioral, social, and cognitive skills that enable students to effectively navigate complex and dynamic innovation ecosystems. In this context, the concept of Personal Entrepreneurial Competencies (PECs) has become a significant reference for understanding and promoting entrepreneurial behavior, as it describes a set of observable characteristics associated with action, decision-making, and resource mobilization in uncertain environments [9]. This shift from entrepreneurial intention to transferable and assessable skills is particularly relevant in engineering education, where professional performance demands integrating technical knowledge with influence, coordination, and value creation skills alongside multiple stakeholders [1].

In accordance with this conceptual development, research indicates that innovation-driven entrepreneurship is associated with learning processes, stakeholder collaboration, and value creation that extend beyond the mere establishment of new enterprises. This underscores the necessity of fostering entrepreneurial competencies within university environments. Empirical reviews and meta-analyses substantiate that entrepreneurial education can produce beneficial impacts on variables related to entrepreneurial activity; however, these impacts are contingent upon pedagogical design, the duration of educational experiences, and the methodological rigor of evaluations. Additionally, in the engineering domain, recent scholarly investigations particularly emphasize the significance of transversal skills — including communication, collaboration, critical thinking, and creativity — to effectively address the evolving demands of the labor market and innovation ecosystems.

A particularly critical aspect within this body of research is related to assessment. Although self-report instruments have been widely used, various reviews point out the limitations of inferring actual performance solely from subjective perceptions, especially in complex and socio-behavioral skills [6]. Research on self-assessment shows that, without explicit criteria and structured feedback, students tend to overestimate their levels of competence [13]. In response, the literature promotes performance-oriented assessments—behavioral indicators, authentic tasks, and analytical rubrics—that allow observation of competence in action in contexts close to professional practice [14], [15]. Recent systematic reviews reinforce the importance of authentic assessment in higher education, highlighting its contribution to demonstrating transferable skills and aligning learning outcomes, activities, and evaluative criteria, especially in online environments [16], [17].

In particular, within the set of PECs, those of a relational and psychological nature—persuasion and support networks, self-confidence, and opportunity detection—are of

particular importance due to their connection with identifying relevant actors, strategic influence, and resource mobilization in innovation and entrepreneurship contexts [18], [19]. In this framework, networking is not conceptualized as a specific PEC but as a transversal strategic capacity aimed at creating, maintaining, and mobilizing relationships for professional and entrepreneurial purposes. Recent literature emphasizes that networking is not limited to casual contact but is nourished by the ability to persuade and build support networks in a sustained manner through intentional, reciprocal interactions aimed at mobilizing relational resources [20]. Longitudinal studies show that this sustained relational behavior is associated with more successful career trajectories and greater access to opportunities [21], [22].

From a theoretical perspective, networking can be understood as a mechanism for the accumulation and activation of social capital, that is, resources available through networks of relationships that facilitate information, support, and legitimacy [23]. Subsequent research distinguishes structural, relational, and cognitive dimensions of social capital, explaining how networks influence the generation of opportunities and performance [24]. Foundational classics highlight the importance of weak ties for accessing non-redundant information [25] and of intermediary positions for the generation and dissemination of innovative ideas [26]. Recent empirical evidence confirms that social capital influences network mobilization and the creation of entrepreneurial value in university and regional contexts [27], [28].

While the online modality enhances access and flexibility, it concurrently presents challenges associated with technology-mediated interaction. Systematic reviews demonstrate that cultivating socio-behavioral skills within online environments necessitates deliberate instructional design, structured feedback, and genuine assessment [8], [29]. Recent research highlights the significance of coherence among tasks, criteria, and feedback to facilitate the progressive development of complex skills in online higher education [30].

In summary, the literature converges on the idea that entrepreneurial competencies should be understood as interdependent systems, whose assessment requires triangulation between self-perception and observable performance. The Entrepreneurial Mindset Learning (EML) approach, promoted by KEEN, offers an integrative framework by emphasizing the consistency between learning outcomes, formative experiences, and evaluation criteria [1]. In this context, a gap remains in the evidence regarding how the persuasion and support network competencies develop and manifest in fully online settings, particularly when analyzing their relationship with networking and social capital through rigorous evaluative designs.

In line with the reviewed literature, entrepreneurial skills — particularly those of a relational nature such as persuasion and the creation of support networks — can be understood as multidimensional constructs that combine perceptual and behavioral components. From this perspective, their assessment requires considering both the student's self-perception and observable evidence of performance in authentic contexts.

Consequently, this study operationalizes these competencies through three complementary sources of evidence: pre- and post-measurements of entrepreneurial skills via self-report, aimed at capturing changes in individual perception; performance assessment through an authentic task measured by an analytical rubric; and overall academic results, considered as a complementary indicator of convergence in performance. This triangulation allows for analyzing not only the existence of perceived changes but also their relationship with actual performance in application contexts.

Methodology

The research used a quantitative, non-experimental, descriptive-comparative design. Data were collected via a questionnaire administered to university students enrolled in the Innovation and Entrepreneurship Workshop, an online course aimed at enhancing Personal Entrepreneurial Competencies, offered by the School of Engineering at Chile's top private university. Participants were invited to complete the questionnaire during sessions and via email. Before administering the questionnaire, students received an informed consent form that explained their rights, including the right to withdraw at any time, and guaranteed the anonymity and confidentiality of their responses.

The study was conducted in the Innovation and Entrepreneurship Workshop I, an entirely online course offered to working students. The course lasts 13 weeks and is structured around pre-packaged instructional materials, interactive activities, and synchronous support sessions, complemented by weekly written feedback. The instructional design aims to develop entrepreneurial skills progressively through an applied project, incorporating activities that simulate networking situations and promote decision-making in realistic contexts. It also includes self-awareness activities and the development of improvement plans to activate networks. Assessment is based on authentic tasks with rubrics and instructor feedback, culminating in an activity where students must demonstrate how they would activate their networks in applied contexts. This design provides insight into the practical opportunities for developing relational skills in online environments.

The sample consisted of 44 students from a private Chilean university, selected through non-probability convenience sampling. All participants were enrolled in the online modality of the Innovation and Entrepreneurship Workshop, and the expected learning outcomes were consistent across the course: applying Personal Entrepreneurial Competencies (PECs) to successfully undertake an entrepreneurial project. The gender distribution included 36 men (81.8%) and 8 women (18.2%). Participants' mean age was 33.53 years (SD = 6.96; range: 21–49; valid n = 43). Regarding prior entrepreneurial experience, 12 students (27.3%) reported having experience in entrepreneurship, while 32 (72.7%) reported no prior experience.

The instrument used was the Personal Entrepreneurial Characteristics (PECs) Questionnaire. This tool assesses individual entrepreneurial competencies using items on a five-point Likert scale, with response options ranging from "never true" to "always true." The original PECs scale measures 10 core dimensions considered essential for an

entrepreneurial profile, but in this case, we focused on: Opportunity Seeking, Persuasion and support network, and Self-Confidence. This instrument has been widely used by other authors in previous research in Chile, demonstrating adequate internal consistency, with Cronbach's alpha reliability values exceeding 0.78 in various university and professional contexts [31]. Given the limited sample size (N = 44), reliability indices for the present sample were not re-estimated; the analyses therefore rely on the previously documented psychometric properties of the instrument, and this constraint is discussed explicitly in the Limitations section.

In this study, we operationalize persuasion and support-network through the interrelation of three self-report dimensions, opportunity seeking, self-confidence, and persuasion and support-network, which jointly represent students' perceived readiness to influence stakeholders and mobilize support. Complementarily, we assess persuasion-related performance through an authentic task evaluated with a rubric capturing intention (purposeful orientation to influence), relevance (strategic alignment of proposed actions with goals and context), and classification (accurate identification and application of networking types). This dual operationalization enables us to examine (a) pre–post changes in perceived facets, and (b) the extent to which perceived competence aligns with observed performance.

Results

Table 1 summarizes descriptive statistics for all study variables (N = 44). Pretest self-perception scores were moderate to high across the three competency dimensions—opportunity seeking (M = 3.827, SD = 0.382), persuasion (M = 3.691, SD = 0.666), and self-confidence (M = 4.014, SD = 0.417), with comparable posttest levels (opportunity seeking: M = 3.991, SD = 0.452; persuasion: M = 3.745, SD = 0.670; self-confidence: M = 4.159, SD = 0.449). Performance indicators reflected a high average task grade (M = 6.293, SD = 1.026) and a rubric total score of M = 7.591 (SD = 1.499); rubric subdimensions were intention (M = 2.750, SD = 0.438), relevance (M = 2.432, SD = 0.625), and classification (M = 2.409, SD = 0.726). Distributional indices further suggested departures from normality for several variables, including pronounced negative skew in grades (skewness = −1.700) and in some self-report indicators (e.g., pretest persuasion and networking skewness = −1.198; intention skewness = −1.196), as well as elevated kurtosis (e.g., pretest persuasion and networking kurtosis = 3.507; grades kurtosis = 2.842). Given these distributional characteristics and the ordinal, Likert-type measurement of the self-report scales, subsequent analyses relied primarily on nonparametric procedures (Wilcoxon signed-rank tests and Spearman's rank-order correlations).

Normality checks on the paired differences indicated deviations from normality for persuasion and networking (Shapiro–Wilk, p = .014), supporting the use of nonparametric tests. Paired-samples Wilcoxon signed-rank tests (two-tailed) were used to compare pre- and post-intervention scores across three competency dimensions (Table 2). P-values were adjusted with the Holm procedure (m = 3) to control the familywise error rate. Scores increased from pre to post for opportunity seeking (PRE: M = 3.827, SD = 0.382; POST: M = 3.991, SD = 0.452), W = 120.5, z = −2.859, p = .004, p_{Holm} = .012, HL = −0.200, 95% CI

[−0.400, −0.100], rank-biserial r = −.570, 95% CI [−.778, −.252]. No evidence of change was observed for persuasion (PRE: M = 3.691, SD = 0.666; POST: M = 3.745, SD = 0.670), W = 207.0, z = −0.524, p = .606, p_{Holm} = .606, HL = −0.100, 95% CI [−0.400, 0.200], r = −.110, 95% CI [−.478, .291]. For self-confidence, the pre–post difference was marginal and did not remain significant after adjustment (PRE: M = 4.014, SD = 0.417; POST: M = 4.159, SD = 0.449), W = 236.0, z = −1.951, p = .051, p_{Holm} = .102, HL = −0.200, 95% CI [−0.400, -2.074×10^{-5}], r = −.363, 95% CI [−.632, −.016].

Table 1. Descriptive statistics and distributional indices for study variables (N = 44)

	Mean	**Std. Deviation**	**Skewness**	**Kurtosis**
PRE Opportunity seeking	3.827	0.382	-0.517	-0.593
PRE Persuasion	3.691	0.666	-1.198	3.507
PRE Self-confidence	4.014	0.417	-0.176	0.003
POST Opportunity seeking	3.991	0.452	-0.750	0.934
POST Persuasion	3.745	0.670	-0.583	0.284
POST Self-confidence	4.159	0.449	-0.209	-0.201
Grades	6.293	1.026	-1.700	2.842
Intention	2.750	0.438	-1.196	-0.599
Relevance	2.432	0.625	-0.629	-0.494
Classification	2.409	0.726	-0.816	-0.619
Rubric	7.591	1.499	-0.943	0.190

Spearman's rank-order correlations were used to examine associations among students' self-perceived competencies and performance indicators at pretest and posttest (Table 3). At pretest, the three self-perception dimensions were strongly intercorrelated (ρ = .495–.663, ps < .001), whereas these associations were smaller at posttest (ρ = .322–.531, ps = .033 to < .001), suggesting reduced overlap among the competency ratings over time. In contrast, self-perceived competencies showed no meaningful association with performance outcomes at either time point. Pretest self-perceptions were not significantly related to the task grade (ρ = .008 to −.146, ps = .346–.961) or to the detailed rubric score (ρ = −.060 to −.132, ps = .392–.701), and the same pattern held at posttest (grades: ρ = −.032 to .116, ps = .455–.914; rubric: ρ = −.069 to .083, ps = .591–.675). Meanwhile, the task grade was strongly aligned with the rubric-based evaluation (ρ = .905, p < .001), indicating convergence between the global grade and the more fine-grained performance assessment

Table 2. Pre–post differences in competencies (Wilcoxon signed-rank tests, N = 44)

Dimension	**Pre M (SD)**	**Post M (SD)**	**W**	**p two-tailed**	**p Holm**	**Rank-biserial r [95% CI]**
Opportunity seeking	3.827 (0.382)	3.991 (0.452)	120.5	.004	.012	−.570 [−.778, −.252]
Persuasion	3.691 (0.666)	3.745 (0.670)	207.0	.606	.606	−.110 [−.478, .291]
Self-confidence	4.014 (0.417)	4.159 (0.449)	236.0	.051	.102	−.363 [−.632, −.016]

Table 3. Spearman correlations between selected PEC´s and performance indicators (N = 44)

Dimensions			Spearman's rho	p
PRE Opportunity seeking	-	PRE Persuasion	0.663***	< .001
PRE Opportunity seeking	-	PRE Self-confidence	0.507***	< .001
PRE Opportunity seeking	-	Grades	-0.008	.959
PRE Opportunity seeking	-	Rubric	-0.060	.701
PRE Persuasion	-	PRE Self-confidence	0.495***	< .001
PRE Persuasion	-	Grades	-0.043	.782
PRE Persuasion	-	Rubric	-0.131	.398
PRE Self-confidence	-	Grades	-0.131	.397
PRE Self-confidence	-	Rubric	-0.132	.392
POST Opportunity seeking	-	POST Persuasion	0.416**	.005
POST Opportunity seeking	-	POST Self-confidence	0.531***	< .001
POST Opportunity seeking	-	Grades	0.095	.542
POST Opportunity seeking	-	Rubric	0.083	.591
POST Persuasion	-	POST Self-confidence	0.322*	.033
POST Persuasion	-	Grades	-0.020	.895
POST Persuasion	-	Rubric	-0.065	.675
POST Self-confidence	-	Grades	0.036	.814
POST Self-confidence	-	Rubric	-0.069	.655
Grades	-	Rubric	0.905***	< .001

* p < .05, ** p < .01, *** p < .001

Individual-level change was examined using Δ scores (post − pre). Changes were summarized in Table 4 both in terms of typical magnitude (median and interquartile range) and direction (negative, zero, or positive). For opportunity seeking, the median change was positive (Md = 0.20, IQR [0.00, 0.40]); 52.3% of students showed positive change, 25.0% showed no change, and 22.7% showed negative change. For persuasion, the typical change was null (Md = 0.00, IQR [−0.20, 0.40]); positive and negative changes occurred with equal frequency (34.1% each), and 31.8% showed no change. For self-confidence, the median change was positive (Md = 0.20, IQR [−0.20, 0.60]); 56.8% of students showed positive change, 13.6% showed no change, and 29.5% showed negative change.

Table 4. Distribution and magnitude of individual change scores (Δ = post − pre), N = 44

Dimension	Md (IQR)	Negative Δ (%)	No change Δ (%)	Positive Δ (%)
Opportunity Seeking	0.20 [0.00, 0.40]	10 (22.7)	11 (25.0)	23 (52.3)
Persuasion	0.00 [−0.20, 0.40]	15 (34.1)	14 (31.8)	15 (34.1)
Self-confidence	0.20 [−0.20, 0.60]	13 (29.5)	6 (13.6)	25 (56.8)

Note. Δ scores were computed as post − pre. Percentages are within dimension; IQR = interquartile range (25th–75th percentile).

Spearman's rank-order correlations examined whether changes in self-perceived competencies (Δ = post − pre) were associated with performance (Table 5). None of the change scores was significantly related to the task grade (ρ = .090–.152, ps = .323–.560) or to the detailed rubric score (ρ = .077–.113, ps = .465–.621), indicating that larger self-perceived gains did not correspond to higher observed performance. Visual inspection of the scatterplots presented in Figure 1 and Figure 2 was consistent with these results: Δ scores showed substantial dispersion at each performance level, with no clear monotonic trend. In addition, grades were strongly aligned with the rubric-based evaluation (ρ = .905, p < .001), suggesting that the global grade closely tracked the more fine-grained performance assessment.

Table 5. Spearman correlations between change scores (Δ = post − pre) and performance indicators (N = 44)

	Δ Opportunity Seeking	**Δ Persuasion**	**Δ Self-confidence**	**Rubric**	**Grades**
1. Δ Opportunity Seeking	— —				
2. Δ Persuasion	0.219 .153	— —			
3. Δ Self-confidence	0.087 .573	0.082 .599	— —		
4. Rubric	0.107 .490	0.113 .465	0.077 .621	— —	
5. Grades	0.090 .560	0.110 .476	0.152 .323	0.905*** < .001	— —

*** p < .001

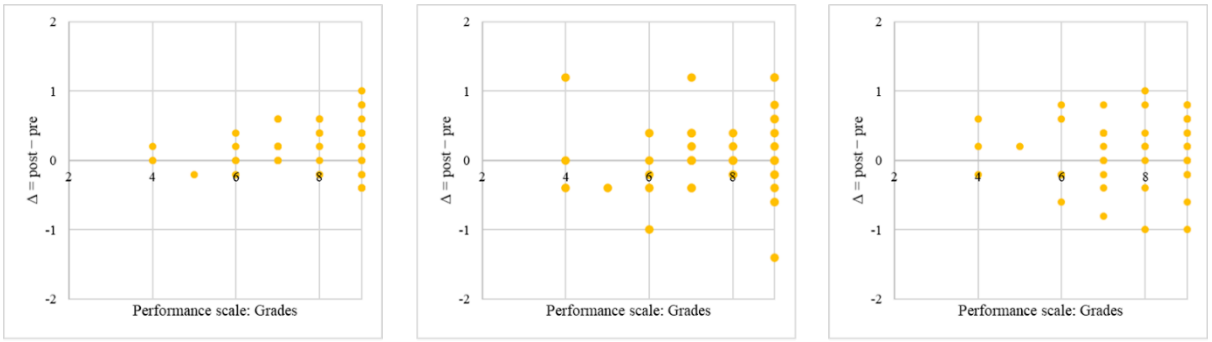

Figure 1. Change in opportunity seeking, persuasion, and self-confidence (Δ) as a function of task rubric.

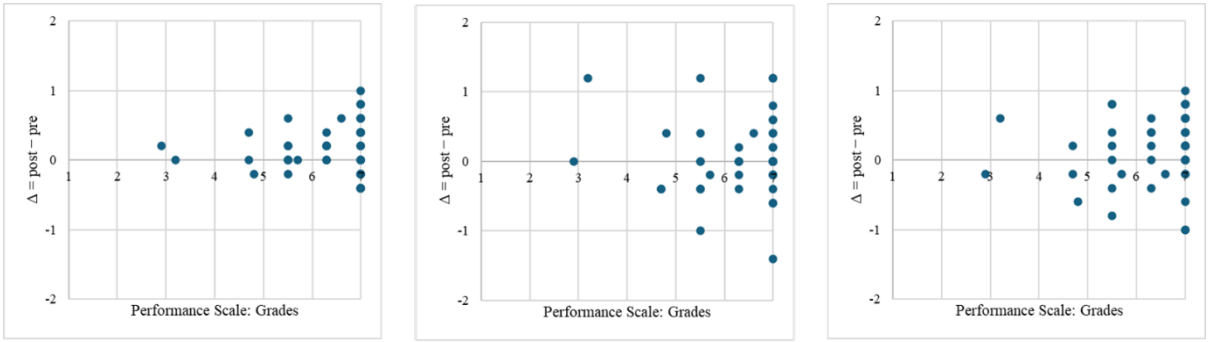

Figure 2. Change in opportunity seeking, persuasion, and self-confidence (Δ) as a function of task grade.

Discussion

This study aimed to analyze the development of Personal Entrepreneurial Competence (PEC) in persuasion and support networks, along with networking understood as a transversal strategic capacity oriented toward mobilizing relational resources, in engineering students enrolled in a fully online program aimed at adult workers. To enrich the understanding of this core competence, PECs in opportunity detection and self-confidence were also incorporated, based on the theoretical assumption that they operate as enabling conditions—though not sufficient on their own—for the effective deployment of persuasion and networking in innovation contexts [3], [5], [18]. Consistent with this profile, the descriptive statistics of the study presented in Table 1 show moderate to high pretest levels in the three dimensions and an overall high performance in the deliverable task.

The results confirm a widely documented issue in the entrepreneurship education literature: the persistent gap between self-perceived competence and observable performance [6], [7], [13]. In this study, students reported relatively high initial levels of self-perception in the three evaluated entrepreneurial competencies (Table 1); however, no significant associations were identified between these perceptions and the performance demonstrated in the authentic task assessed through a rubric (Table 3). This finding reinforces the need to move beyond evaluative approaches that rely solely on self-report, especially when it comes to complex socio-behavioral skills such as persuading, influencing, and mobilizing support networks [6], [13].

The analysis of the pre–post changes presented in Table 2 shows a differentiated pattern among the PECs. While opportunity detection showed significant increases ($p_{Holm} = .012$; effect size rank-biserial $r = -.570$), persuasion and support networks did not exhibit relevant perceptual changes, and self-confidence showed marginal variations that were not sustained after adjustment for multiple comparisons. This result suggests that skills related to exploring the environment, identifying needs, and recognizing opportunities may be more sensitive to short-term training interventions, even in online mode [29]. In contrast, relational skills linked to persuasion and networking seem to require longer learning processes, characterized by sustained social interaction, explicit feedback, and situated

experiences that allow individuals to experience real consequences of the influence exerted [8], [14], [16].

From the perspective of the Entrepreneurial Mindset Learning (EML) promoted by KEEN, these results are particularly relevant. EML posits that entrepreneurship is not defined by intention or by the subjective perception of competence, but by the ability to act to create value, influence others, and make decisions under uncertainty [1]. In this sense, the absence of a relationship between self-perception and performance does not constitute a weakness of the training design, but rather highlights that the entrepreneurial mindset can only be validly assessed when observed in action [6], [7]. The strong convergence between the overall rating of the deliverable and the analytical rubric supports the validity of the authentic assessment used and its coherence with this approach (Table 3).

A significant contribution of the study emerges from the analysis of the individual changes presented in Table 4. The balanced distribution of increases, decreases, and no change in self-perception of persuasion and support networks, along with the coexistence of improvements and declines in self-confidence, suggests the presence of heterogeneous change trajectories and possible metacognitive adjustment processes. It is plausible that, when faced with authentic networking tasks, students develop a more realistic understanding of the complexity involved in strategically influencing others, identifying relevant actors, and mobilizing support in a sustained manner [13], [15]. From this perspective, the absence of perceptual increases should not necessarily be interpreted as a formative failure but rather as a sign of maturation of personal judgment, consistent with experiential learning approaches and the principles of EML [1], [19].

Likewise, the results support the theoretical decision to conceptualize networking not as an isolated skill, but as a transversal strategic capacity that emerges from the articulated deployment of multiple skills [18], [20]. The fact that none of the evaluated competencies—persuasion and support networks, opportunity detection, or self-confidence—are directly related to observable performance, both in pre/post levels (Table 3) and in terms of changes (Table 5), reinforces the idea that entrepreneurship should be understood as an interdependent system of skills, whose manifestation depends on the context, the task, and the quality of learning experiences [6], [18]. This view is consistent with the literature that warns that contacting people does not equate to mobilizing strategic support, and that effective networking involves intentionality, coherence between objectives and actions, and the progressive activation of social capital [20], [23], [24].

The fully online context is a key element for interpreting these results. While this modality increases access and flexibility—especially for working adults—it also introduces restrictions related to technology-mediated interaction, time availability, and the diversity of previous trajectories [8], [29]. These conditions can limit opportunities for spontaneous social practice and immediate feedback, which are critical aspects for developing complex relational skills [16], [30]. In this framework, Figures 1 and 2 complement the correlational evidence in Table 5 by showing a high dispersion of changes (Δ) at each performance level, with no clear monotonic trend, which reinforces the conclusion that greater gains in self-perception do not necessarily translate into better observed performance.

This study presents limitations that should be considered when interpreting the findings. First, it is a pre–post design without a control group, which prevents establishing robust causal relationships. Second, the study was conducted in a single course of a specific program, limiting the generalization of the results. Third, the effective sample size was reduced to students with complete data, which could introduce biases related to dropout or differential participation. Finally, although the rubric showed high convergence with the overall grade (Table 3), no formal inter-rater reliability indicators were reported.
Two additional methodological constraints warrant explicit discussion. First, the sample composition (N = 44; 81.8% male; M age = 33.53, SD = 6.96, range 21–49; 27.3% with prior entrepreneurial experience vs. 72.7% without) is relatively homogeneous in some respects—predominantly male, working adults in a degree-completion program—and asymmetric in others, particularly the distribution of prior entrepreneurial experience. With N = 44, sub-group comparisons by gender, age band, or prior experience, as well as multivariate regressions controlling for these variables, would be substantially underpowered and yield unreliable estimates; we therefore did not pursue formal sensitivity analyses with these covariates. Future replications with larger and more balanced samples should systematically test whether the reported associations and pre–post patterns hold across these subgroups. Second, given the limited sample size, internal consistency indices (Cronbach's α or McDonald's ω) for the PEC subscales were not re-estimated for the present sample; the analyses rely on the previously documented psychometric properties of the instrument [31], and sample-specific reliability evidence remains a methodological constraint that future studies with larger N should address.

Future research should move toward longitudinal designs, incorporate multiple authentic iterative tasks, and explore comparisons between online, hybrid, and in-person modalities [8], [16], [29]. Additionally, it is relevant to deepen the qualitative analysis of deliverables to identify recurring patterns of difficulty and transform them into explicit pedagogical scaffolds. Finally, it is recommended to more directly explore the relationship between networking, social capital, and entrepreneurial outcomes, especially in programs aimed at working professionals [23], [27], [28].

The results suggest that entrepreneurial skills do not respond uniformly to online interventions. Opportunity detection showed significant improvements (Wilcoxon, adjusted $p < .05$), indicating that it is sensitive to activities such as context analysis, needs identification, and proposal development. In contrast, persuasion and the formation of support networks did not show significant changes, suggesting the need to incorporate more intensive and sustained practices. In this regard, it is recommended to integrate iterative pitch cycles with structured feedback, role-playing activities, simulations, and opportunities for interaction with external actors to promote network activation in more authentic contexts. Self-confidence, which showed marginal changes, could be strengthened through support strategies such as mentoring or ongoing formative feedback. Finally, the results reinforce the importance of using dual assessment—self-report and observable performance—to address the gap between perception and action in socio-behavioral skills.

Conclusions

This study provides evidence to the field of engineering education and entrepreneurial education by examining the development of persuasion and support networks as Personal Entrepreneurial Competence and its link to networking understood as a transversal strategic capacity aimed at mobilizing relational resources, in a fully online program aimed at adult workers. In a context where entrepreneurial training is expanding in flexible and asynchronous formats, the results help to clarify which dimensions of entrepreneurial learning appear to be more sensitive to change in targeted interventions and which require longer pedagogical designs to translate into consistent improvements.

The findings show a different pattern among competencies. There are advances in opportunity detection, which suggests that dimensions such as exploring the environment and reading scenarios can benefit from brief interventions, even online. However, persuasion, support networks, and self-confidence do not show significant perceptual changes or only exhibit marginal variations. This indicates that the more complex competencies—such as influence, mobilizing support, and activating networks—are less susceptible to short-term change without ongoing social interaction, specific feedback, and practice in real-world conditions.

A key finding is the lack of a relationship between self-perception and observable performance. Levels of self-perception (pre and post) and changes (Δ) are not significantly associated with performance on the authentic task, which was evaluated with a rubric and overall grade. This indicates that feeling more competent does not always mean better performance in activities that require coherence between goals and actions, as well as mobilization of relational resources. Therefore, the study highlights the importance of dual assessment strategies: self-reports for the subjective dimension and behavioral evidence from authentic tasks.

In pedagogical terms, the results suggest that developing persuasion and networking skills in online environments requires additional intentionality, including authentic iterative tasks, structured social interaction, and explicit feedback on influence strategies. This study should be interpreted considering its limitations (pre–post design without control, application in a single course, limited sample size, and lack of inter-rater reliability). In the future, it is recommended to move toward longitudinal designs, incorporate multiple repeated authentic tasks, compare modalities, and complement with qualitative analysis of the deliverables to turn recurring difficulties into explicit pedagogical scaffolds.

Acknowledgments

The authors acknowledge the leadership and financial support of the School of Engineering, as well as the Educational Research and Academic Development Unit (UNIDA) for its mentorship and guidance in strengthening research capabilities in higher education.

Referencias

[1] L. Bosman and M. Phillips, "Integrating the entrepreneurial mindset into the engineering classroom," *IEEE Trans. Educ.*, vol. 65, no. 2, pp. 150–155, 2022, doi: 10.1109/TE.2021.3101360.

[2] C. Gwynn and M. E. Truyol, "Relationship among entrepreneurial intention and entrepreneurial competency development," in *Proc. ASEE Annu. Conf. Expo.*, 2024, Paper 47936, doi: 10.18260/1-2--47936.

[3] J. L. González-Pernía, I. Peña-Legazkue, and F. Vendrell-Herrero, "Innovation, entrepreneurial activity and competitiveness at a sub-national level," *Small Business Economics*, vol. 39, no. 3, pp. 561–574, 2012, doi: 10.1007/s11187-011-9330-y.

[4] Y. Zhang, G. Duysters, and M. Cloodt, "The role of entrepreneurship education as a predictor of university students' entrepreneurial intention," *International Entrepreneurship and Management Journal*, vol. 10, no. 3, pp. 623–641, 2014, doi: 10.1007/s11365-012-0246-z.

[5] P. Westhead and M. Z. Solesvik, "Entrepreneurship education and entrepreneurial intention: Do female students benefit?," International Small Business Journal: Researching Entrepreneurship, vol. 34, no. 8, pp. 979–1003, 2016, doi: 10.1177/0266242615612534.

[6] A. Y. Huang-Saad, C. S. Morton, and J. C. Libarkin, "Entrepreneurship assessment in higher education," *J. Eng. Educ.*, vol. 107, no. 2, pp. 263–290, 2018, doi: 10.1002/jee.20197.

[7] S. E. Zappe, "A systematic review of the impacts of entrepreneurial mindset education," *Entrep. Educ. Pedagogy*, vol. 6, no. 1, pp. 3–31, 2023, doi: 10.1177/25151274211040422.

[8] E. Liguori and C. Winkler, "From offline to online," *Entrep. Educ. Pedagogy*, vol. 3, no. 4, pp. 346–351, 2020, doi: 10.1177/2515127420916738.

[9] C. P. Arguello Mendoza, D. R. Barba Bayas, and P. V. Micolta Salas., "Características emprendedoras personales," *Rev. Ciencia UNEMI*, vol. 16, no. 43, pp. 48–60, 2023, doi: 10.29076/issn.2528-7737vol16iss43.2023pp48-60p.

[10] G. Nabi, F. Liñán, A. Fayolle, N. Krueger, and A. Walmsley, "The impact of entrepreneurship education in higher education: A systematic review and research agenda," *Academy of Management Learning & Education*, vol. 16, no. 2, pp. 277–299, 2017, doi: 10.5465/amle.2015.0026.

[11] C. Gupta and V. Gupta, "C4 skills in the engineering graduate: A study to align software engineering education with market-driven software industry needs," *IEEE Transactions on Education*, vol. 67, no. 1, pp. 31–43, 2024, doi: 10.1109/TE.2023.3301625.

[12] J. Daley and B. Baruah, "Leadership skills development among engineering students in higher education—An analysis of the Russell Group universities in the UK," European Journal of Engineering Education, vol. 46, no. 4, pp. 528–556, 2021, doi: 10.1080/03043797.2020.1832049.

[13] H. L. Andrade, "A critical review of research on student self-assessment," Frontiers in Education, vol. 4, Art. no. 87, 2019, doi: 10.3389/feduc.2019.00087.

[14] J. Seikkula-Leino and M. Salomaa, “Bridging the research gap—A framework for assessing entrepreneurial competencies based on self-esteem and self-efficacy,” *Education Sciences*, vol. 11, no. 10, Art. no. 572, 2021, doi: 10.3390/educsci11100572.
[15] V. Villarroel, S. Bloxham, D. Bruna, C. Bruna, and C. Herrera-Seda, “Authentic assessment: Creating a blueprint for course design,” *Assessment & Evaluation in Higher Education*, vol. 43, no. 5, pp. 840–854, 2018, doi: 10.1080/02602938.2017.1412396.
[16] D. Vlachopoulos and A. Makri, “A systematic literature review on authentic assessment in higher education: Best practices for the development of 21st century skills, and policy considerations,” Studies in Educational Evaluation, vol. 83, Art. no. 101425, 2024, doi: 10.1016/j.stueduc.2024.101425.
[17] J. Heil and D. Ifenthaler, “Online assessment in higher education,” *Online Learn. J.*, vol. 27, no. 1, 2023, doi: 10.24059/olj.v27i1.3398.
[18] K. N. Mai and Q. H. Thai, “Entrepreneurial competencies – A systematic literature review,” *Journal of International Entrepreneurship*, vol. 23, no. 1, pp. 54–130, 2025, doi: 10.1007/s10843-024-00356-7.
[19] V. F. Motta and S. V. R. Galina, “Experiential learning in entrepreneurship education: A systematic literature review,” *Teaching and Teacher Education*, vol. 121, Art. no. 103919, 2023, doi: 10.1016/j.tate.2022.103919.
[20] S. Singh and S. Basri, “Antecedents of entrepreneurial networking behavior,” *F1000Research*, vol. 13, 2024, doi: 10.12688/f1000research.150032.1.
[21] H.-G. Wolff and K. Moser, “Effects of networking on career success: A longitudinal study,” *Journal of Applied Psychology*, vol. 94, no. 1, pp. 196–206, 2009, doi: 10.1037/a0013350.
[22] D. Spurk, S. Kauffeld, L. Barthauer, and N. S. R. Heinemann, “Fostering networking behavior, career planning and optimism, and subjective career success: An intervention study,” *Journal of Vocational Behavior*, vol. 87, pp. 134–144, 2015, doi: 10.1016/j.jvb.2014.12.007.
[23] J. Nahapiet and S. Ghoshal, “Social capital, intellectual capital, and the organizational advantage,” The Academy of Management Review, vol. 23, no. 2, pp. 242–266, 1998, doi: 10.2307/259373.
[24] P. S. Adler and S.-W. Kwon, “Social capital: Prospects for a new concept,” The *Academy of Management Review*, vol. 27, no. 1, pp. 17–40, 2002, doi: 10.2307/4134367.
[25] M. S. Granovetter, “The strength of weak ties,” *American Journal of Sociology*, vol. 78, no. 6, pp. 1360–1380, 1973, doi: 10.1086/225469.
[26] R. S. Burt, “Structural holes and good ideas,” *American Journal of Sociology*, vol. 110, no. 2, pp. 349–399, 2004, doi: 10.1086/421787.
[27] V. Chlebovský, M. Goldberg, T. Cashon, and J. Ulč, “Building a successful university entrepreneurial ecosystem—Lessons learned from U.S. and European universities,” *SSRN*, Preprint, 2025, doi: 10.2139/ssrn.5340794.
[28] M. Reddy, J. C. Nardelli, Y. L. Pereira, L. B. Oliveira, T. H. Silva, M. Vasconcelos, and M. Horowitz, “Higher education’s influence on social networks and entrepreneurship in Brazil,” *Social Network Analysis and Mining*, vol. 13, no. 1, Art. no. 2, 2022, doi: 10.1007/s13278-022-01011-6.

[29] L. Chen, D. Ifenthaler, and J. Y.-K. Yau, “Online and blended entrepreneurship education: A systematic review of applied educational technologies,” *Entrepreneurship Education*, vol. 4, no. 2, pp. 191–232, 2021, doi: 10.1007/s41959-021-00047-7.

[30] F. Martin, S. Kim, D. U. Bolliger, and J. DeLarm, “Assessment types, strategies, and feedback in online higher education courses in the age of artificial intelligence: Perspectives of instructional designers,” *TechTrends*, vol. 69, no. 6, pp. 1330–1346, 2025, doi: 10.1007/s11528-025-01115-8.

[31] J. Sepúlveda Maldonado, M. Denegri Coria, L. Orellana Calderón, N. Criado, J. Mendoza, P. Salazar, and G. Yung, "Personal entrepreneurial characteristics and economic literacy: A comparison between university students of southern Chile," *Interdisciplinaria*, vol. 34, no. 1, pp. 107–124, 2017.