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Entrepreneurial intention in higher education during COVID-19: evidence of stability and comparability across student groups and time

Purpose The main objective of this paper is to assess the measurement invariance of a short questionnaire assessing students' entrepreneurial intention (EI) over time and across key subgroups (gender, higher education institution (HEI) typology, course typology) during the COVID-19 pandemic.

Design/methodology/approach A multigroup confirmatory factor analysis was conducted on data collected from undergraduate students enrolled in entrepreneurship modules at Portuguese HEIs during the second semester of the 2019/2020 academic year.

Findings There is evidence of configural, metric and scalar invariance of the covariance structure of the 6-item scale of students' EI by gender, HEI typology and course typology, and over time (before and after entrepreneurship modules). In the context of the COVID-19 pandemic, these findings suggest that the 6-item scale of EI is psychometrically equivalent across key subgroups of entrepreneurship students in HEIs and over time.

Originality This study introduces a crisis-sensitive framework for entrepreneurial intention measurement that integrates contextualist, planned behaviour, and digital entrepreneurship perspectives. By theorising crisis-driven contextual convergence and platform-enabled homogenisation, it refines contextualist, planned behaviour, and digital entrepreneurship perspectives on intention stability under disruption and clarifies when EI comparisons remain psychometrically valid in turbulent environments.

Practical implications Although it is difficult to foster students' EI in a pandemic context, those responsible for higher education must be ready to introduce new pedagogical tools in future emergency situations.

Keywords: entrepreneurial intention; measurement invariance; higher education institutions; multi-group analysis; entrepreneurial process; crisis

Introduction

The COVID-19 pandemic, hereafter referred to as the pandemic, generated major public health and economic shocks that disrupted multiple sectors worldwide (Msemburi *et al.*, 2023, Hussain *et al.*, 2022). Governments implemented restrictive measures such as lockdowns, quarantine, and social distancing, contributing to a global economic crisis and heightened uncertainty (Susskind and Vines, 2020, Reis *et al.*, 2020). This unprecedented disruption produced severe socioeconomic consequences across labour, health, and education systems (Brodeur *et al.*, 2021, Nicola *et al.*, 2020), with substantial impacts on students' academic performance and mental health (Lalin *et al.*, 2024).

In Portugal, where this study was conducted, the second semester of the 2019/2020 academic year was interrupted abruptly by the first nationwide lockdown. Higher education students experienced an immediate transition to emergency remote learning, alongside significant health anxieties and economic insecurity.

Such crisis conditions highlight the importance of contextualist perspectives in entrepreneurship research, which emphasises that entrepreneurial cognition and intentionality are shaped by the interaction between individuals and their environments (Mitchell *et al.*, 2002, Welter, 2011, Bird, 1988). At the same time, intention-based theories such as the Theory of Planned Behaviour conceptualise entrepreneurial intention (EI) as a relatively stable cognitive orientation, formed through attitudes, perceived behavioural control, and subjective norms (Ajzen, 1991). EI, as a key precursor to entrepreneurial action and venture creation (Alferaih, 2022), may therefore reflect both enduring cognitive structures and contextual sensitivity under systemic shocks (Cardella *et al.*, 2024). This is especially relevant given the role of higher education institutions (HEIs) in fostering

entrepreneurial mindsets and intentions among students (Qureshi *et al.*, 2023, Tomy and Pardede, 2020), which can contribute to innovation-driven economic recovery in times of crisis (Castro and Zermeño, 2020, Ordeñana *et al.*, 2024).

Despite this expanding body of research, a core methodological gap remains: pandemic-era studies typically assume that EI instruments function equivalently across student groups and time, yet they do not formally test measurement invariance. Addressing this gap, the present study applies multi-group and longitudinal confirmatory factor analysis to examine the invariance of a short EI scale during a systemic crisis, thereby validating the comparability of EI across gender, HEI typology, course typology, and time under disruptive conditions. In doing so, the study provides a crisis-sensitive measurement framework that shows when EI comparisons are psychometrically warranted in turbulent higher education contexts. Otherwise, without establishing measurement invariance, observed differences across gender, institutional contexts, or educational domains may reflect systematic response biases rather than substantive variation in EI. As Vandenberg and Lance (2000) argue, demonstrating measurement equivalence is a prerequisite for meaningful comparisons across groups or over time. Accordingly, this study seeks to address this gap by: (i) testing measurement invariance of EI during a systemic crisis rather than in stable contexts; (ii) examining both cross-group (gender, HEI typology, and course typology) and longitudinal measurement invariance within the same crisis setting; and (iii) demonstrating that observed group differences reported in prior EI studies during the pandemic may be difficult to interpret in the absence of measurement invariance testing.

The remainder of the paper is structured as follows. We start by reviewing the key literature on this topic. The methodology is outlined in section three. The subsequent

sections set out and discuss the results, presenting practical and theoretical implications, and the final section concludes.

Literature review

This section summarises two strands of literature relevant to our study: (i) empirical evidence on EI during the pandemic, including key groups and pedagogical mechanisms in entrepreneurship education; and (ii) the theoretical framework, encompassing the interplay of context and entrepreneurship, the implications of the Theory of Planned Behaviour for EI stability, and the Theory of Digital Entrepreneurship.

Empirical evidence

Students' EI during the pandemic

A number of authors have analysed students' EI during the pandemic in HEIs. While some have confirmed that entrepreneurship programmes in HEIs play an important role in fostering students' EI (Krichen and Chaabouni, 2022, Li *et al.*, 2021, Botezat *et al.*, 2022), Lopes *et al.* (2021) argue that entrepreneurial activity did not decrease during the pandemic period. Using precisely the same sample as Lopes *et al.* (2021), Gomes *et al.* (2021) concluded that the motivational dimension, attitude towards behaviour and perceived behavioural control had a positive impact on students' EI during the pandemic but that subjective norms and the environmental dimension had a negative impact. Employing a structural modelling approach, Botezat *et al.* (2022) concluded that students' EI rose during the pandemic in HEIs. The authors confirmed the relationship between these variables both before and during the pandemic.

On the other hand, heightened concerns regarding students' academic performance during the pandemic have underscored the role of emotional factors - such as worry, despair, and stress (Lalin *et al.*, 2024) - alongside an increased perception of risk and uncertainty (Ning *et al.*, 2024), which together represent significant barriers to the development of an entrepreneurial mindset (Chapman and Phillips, 2022). In addition, Doanh *et al.* (2021) show that students' self-efficacy, EI, and entrepreneurial behaviour were reduced due to fear and anxiety about the pandemic. Simultaneously, economic uncertainty and psychological stress were associated with lower EIs among college students (Sheng and Chen, 2022), and Barnir (2025) suggests that the pandemic was associated with a decline in EI for specific subgroups, particularly female and white students, rather than a generalised decline across the student population. Moreover, Cardella *et al.* (2024, p. 2567) argue that "entrepreneurial intentions are hampered by the perception of COVID-19" but, crucially, added that students' EI was "promoted by the basic psychological needs satisfaction, as a motivational factor, when driven by optimism and proactivity".

Key groups of EI

Conversely, some research has tested students' EI according to groups of analysis. Gender is a typical group studied (Contreras-Barraza *et al.*, 2021, Atienza-Barba *et al.*, 2025, Barnir, 2025); similarly, HEI typology, namely whether the education is more vocational ([1]) (Ojewumi and Fagbenro, 2019, Kusmintarti *et al.*, 2017, Li and Islam, 2021) or oriented

[1] polytechnic institutes, polytechnic universities, vocational/professional universities, technical universities, applied technological universities, college of higher vocational studies, or

toward research and knowledge creation (universities) (Barba-Sánchez *et al.*, 2022, Wegner *et al.*, 2020) has also been analysed. In HEIs, course typology has also been studied in the framework of students' EI; in fact, several studies focus on either business or business and economics programmes to examine students' EI (Contreras-Barraza *et al.*, 2021, Malathi and Venugopal, 2025, Galvão *et al.*, 2025).

Pedagogical mechanisms

The abrupt move to emergency remote teaching constrained the experiential quality of entrepreneurship modules, limiting opportunities for intensive, hands-on projects, authentic interaction with entrepreneurs, and rich team collaboration (Vecchiarini *et al.*, 2024, Ribeiro *et al.*, 2020). More broadly, studies on emergency remote teaching in HEIs show that this rapid, crisis-driven move online - implemented without the planning typical of high-quality online education - exacerbated problems of participation, assessment, and equity (Shazli *et al.*, 2023, Rapanta *et al.*, 2020). In such conditions, entrepreneurship education is less likely to produce sizeable shifts in students' EI over a single semester.

Nevertheless, the transition from emergency remote teaching to hybrid learning environments represents a critical evolution in post-pandemic entrepreneurship education (Ghannad and Sörensson, 2024). Sebastián-Rivera *et al.* (2025) frame this shift as essential for building entrepreneurial resilience, highlighting how blended digital-physical pedagogies support EI development better than fully remote crisis responses.

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universities of applied sciences Brás, G. R. (2021), "Awarding PhD Powers to Polytechnics: An Academic Trap?", *SAGE Open,* Vol. 11 No. 2, pp. 1-15.

Summary

Despite their relevance and scientific contribution, studies such as Lopes *et al.* (2021), Gomes *et al.* (2021), Krichen and Chaabouni (2022) and Botezat *et al.* (2022) report differences in EI across time, programmes, or student characteristics during the pandemic, implicitly assuming that EI measures are comparable across these groups and waves without formally testing measurement invariance.

Without such testing, it remains unclear whether the reported differences reflect genuine changes in latent EI or are partly driven by shifts in how respondents interpret and use the measurement scale under crisis conditions. This underlines the need for a strengthened theoretical and methodological framework that integrates crisis-sensitive contextualist perspectives with rigorous invariance testing when interpreting EI patterns during systemic disruptions.

Theoretical framework

The interplay of context and entrepreneurship

As referred by Welter (2011, p. 165), a 'contextualised view of entrepreneurship contributes to our understanding of the phenomenon'. Recent post-pandemic research has further emphasised the need for context-adaptive entrepreneurial education, reinforcing the growing call within academic scholarship for greater contextualisation of entrepreneurial phenomena (Ben-Hafaïedh *et al.*, 2024). Some authors have drawn particular attention to the importance of studying entrepreneurship in the context of the pandemic (Liñán and Jaén, 2022, Giones *et al.*, 2020, Cardella *et al.*, 2024). While some place greater relevance on the institutional context (Medina-Molina *et al.*, 2025, Garmroudesfandiari *et al.*, 2025),

others highlight the social context (Inoubli and Gharbi, 2024), economic context (Gil-Soto *et al.*, 2024), technological context (Cunningham *et al.*, 2022, Pham *et al.*, 2023) or cognitive context (Lattacher *et al.*, 2021). The far-reaching implications of the pandemic are likely to affect society globally in all these contexts and may have impacted entrepreneurs' decision-making (Audretsch *et al.*, 2022, Pawar, 2020), notably common dimensions in the entrepreneurial process such as risk and uncertainty (Audretsch *et al.*, 2022).

In the education sector, crises can produce broadly similar psychological reactions among learners. Heightened threat perceptions and mortality salience have been shown to shift individuals toward a more prevention-oriented and risk-sensitive regulatory focus (Pyszczynski *et al.*, 2021). During the pandemic, students experienced widespread increases in economic anxiety and perceived uncertainty, which may have shaped EI through common cognitive filters rather than highly differentiated individual appraisals (Fetzer *et al.*, 2021).

In addition, pandemic-related disruptions may have imposed uniform constraints on the educational and institutional environment. Exogenous shocks can homogenise opportunity structures and support conditions, reducing the relevance of pre-existing group-level advantages and contextual resources (Kuckertz *et al.*, 2020). In such settings, behavioural norms may tighten and feasible pathways for entrepreneurial action may narrow, further limiting the explanatory power of typical moderators of EI (Bavel *et al.*, 2020, Gelfand *et al.*, 2021).

Theory of Planned Behaviour and EI stability

Although prior studies document both facilitating and inhibiting factors of students' EI,

intention-based theories conceptualise EI as a relatively stable cognitive construct (Bakker *et al.*, 2020). In particular, the Theory of Planned Behaviour posits that EI is determined by attitudes, perceived behavioural control, and subjective norms, and these typically only change gradually over time (Ajzen, 1991, Fayolle and Liñán, 2014). Consistent with this view, there is evidence that EI exhibits durability and structural stability over time and across contexts, maintaining its underlying cognitive framework even when individuals experience substantial environmental disruptions (Joensuu-Salo *et al.*, 2020, Belchior and Lyons, 2023).

Building on the relative stability of EI, macro-contextual shocks (such as the pandemic) may generate shared psychological responses (Shepherd, 2020) and common environmental constraints that reduce variability in how individuals perceive entrepreneurial opportunities (Davidsson *et al.*, 2018, Jiatong *et al.*, 2022). Under such conditions, traditional differences (e.g., gender, institutional typology, or field of study) may become less influential, thereby increasing the likelihood of psychometric equivalence in EI measurement across student subgroups.

Theory of Digital Entrepreneurship

The Theory of Digital Entrepreneurship (TDE) explores how digital artifacts, platforms, and infrastructures fundamentally reshape the nature of entrepreneurial uncertainty, and the processes used to identify and exploit opportunities (Nambisan, 2017). During global crises such as the pandemic, TDE acts as a critical framework for resilience, allowing organisations to maintain business continuity by pivoting toward digital-first strategies and remote work arrangements (Ratten and Jones, 2021). In the higher education context, digital entrepreneurship education serves as a strategic bridge to EI by enhancing students'

digital self-efficacy and mediating the development of a mindset tailored to digital value creation (Duong *et al.*, 2024). In addition, digital competence boosts students' EI indirectly by heightening their entrepreneurial alertness (mediation), with this effect becoming stronger among students with higher entrepreneurial motivation (moderation) (Zhao *et al.*, 2025).

However, the implementation of digital entrepreneurship among students is hindered by the digital divide, where limited access to essential ICT tools and the psychological impact of virtual isolation can result in substantial learning losses (Browning *et al.*, 2021, van de Werfhorst *et al.*, 2022). Moreover, TDE suggests that platform-based economies create a standardised digital landscape (Ulhøi, 2021) - through uniform access to tools, data interoperability, and low-entry barriers - that may promote structural invariance and relative homogeneity in EI across diverse student populations (Balgiu *et al.*, 2024, Zhang *et al.*, 2025, Youssef *et al.*, 2021). This structural similarity suggests that students share global commonalities that allow for unified institutional policies, as the digital era fosters a consistent and homogenised entrepreneurial spirit among youth regardless of their individual backgrounds.

Summary

The theoretical approaches converge on expecting EI invariance among students during crises: (i) contextualism highlights homogenised psychological reactions and opportunity constraints, (ii) TPB underscores the gradual evolution of stable antecedents, and (iii) TDE posits standardised platforms that reduce cross-group variability. Together, they predict a preserved EI structure over time and across key student groups under pandemic conditions.

Accordingly, establishing temporal and cross-group measurement invariance is essential to ensure that observed differences in students' EI reflect substantive variation rather than measurement artefacts, particularly within post-pandemic higher education and entrepreneurship education contexts. Collectively, these theoretical insights provide a foundation for examining the stability and comparability of students' EI over time and across key student groups.

Methods

Invariance definition and hypotheses

In evaluating group differences in students' EI or over time, it is assumed that the measurement of the EI construct is comparable across groups or for the same sample of students over time (Putnick and Bornstein, 2016). According to Widaman and Reise (1997), several steps should be followed to test measurement invariance when making this evaluation, namely: configural, metric (or weak factorial), scalar (or strong factorial) and residual (or strict) invariance.

The configural invariance model seeks to confirm that the factorial structure does not differ across groups or over time (Hong *et al.*, 2003). The metric invariance model tests whether the factor loadings are equal across groups or over time, but allowing free intercepts between them; and the scalar invariance model aims to test whether factor loadings and intercepts are equal across groups or over time (Dimitrov, 2010). Finally, the residual invariance model is a more stringent invariance measure which assumes that factor loadings, intercepts and residual variances are equal across groups or over time (Dimitrov, 2010). Therefore, based on the literature review, the hypotheses of the study are as follows:

Hypothesis 1 (H1). During the pandemic, there is configural invariance in students' EI across gender, HEI typology, course typology, and over time (beginning of the semester vs end of the semester)

Hypothesis 2 (H2). During the pandemic, there is metric invariance in students' EI across gender, HEI typology, course typology, and over time (beginning of the semester vs end of the semester)

Hypothesis 3 (H3). During the pandemic, there is scalar invariance in students' EI across gender, HEI typology, course typology, and over time (beginning of the semester vs end of the semester)

Hypothesis 4 (H4). During the pandemic, there is residual invariance in students' EI across gender, HEI typology, course typology, and over time (beginning of the semester vs end of the semester)

Instrument and sample

The sample consisted of undergraduate students enrolled in entrepreneurship-related modules at HEIs in Portugal's Central Region, including three universities (University of Coimbra, University of Aveiro, and University of Beira Interior) and four polytechnic institutes (Polytechnic Institutes of Tomar, Castelo Branco, Viseu, and Leiria). In this region, Portuguese HEIs were included if they offered entrepreneurship-related modules during the semester and agreed to distribute the survey through the Moodle platform; the Polytechnic Institute of Coimbra did not express an interest in participating and is the only institution missing from the region. This region provides a suitable context for studying EI in higher education due to its diversity of institutions and educational environments, encompassing urban, semi-urban, and rural settings. Such heterogeneity enables the

examination of EI across varied learning contexts. While not intended to be nationally representative, the sample offers transferable insights into entrepreneurship education beyond major metropolitan areas.

Data were gathered through a self-administered questionnaire completed by students of entrepreneurship modules via Google Forms, and using the convenience sampling method, which has been used in some recent entrepreneurship studies (Sahu and Panda, 2025, Chahal *et al.*, 2024, Saqib *et al.*, 2025). Given the restricted access of students during the emergency remote teaching period, convenience sampling was necessary. The aim of the study is to achieve construct comparability rather than population representativeness. Accordingly, the present study focuses on evaluating the psychometric equivalence of the EI scale across groups and over time, rather than estimating population parameters.

The two-wave online questionnaire was conducted at the beginning and end of the second semester of the 2019/2020 academic year. We used data to examine the measurement invariance of the six-item scale of EI developed by Liñán and Chen (2009) across groups [gender, HEI typology, and course typology (business/economics courses vs. other courses)], and over time [at the beginning of the semester vs. the end of the semester] among students of entrepreneurship modules. The two-wave design served distinct analytical purposes. Cross-sectional measurement invariance across student subgroups (gender, HEI typology, and course typology) was tested using the full Wave 1 sample (n = 279 completed responses). Longitudinal measurement invariance required matched responses and was therefore assessed using the paired subsample (n = 154 paired completed responses), corresponding to 308 repeated observations across two time points [at the beginning of the semester and the end of the semester]. Of the 190 questionnaires returned

in Wave 2, 36 could not be matched to Wave 1 responses due to inconsistent or missing identifiers – please see the following 'procedures' section. This procedure resulted in 154 valid paired responses (308 repeated observations) used for the longitudinal measurement invariance. Table I summarises sample characteristics; full technical specifications (sampling frame, recruitment channel, response rates, matching procedure, and missing-data rules) are provided in Appendix A.

Insert Table I about here

To assess potential attrition bias, we compared respondents from the initial Wave 1 sample (N = 279) who completed both waves (n = 154, 55.2%) with those who participated only in Wave 1 (n = 125, 44.8%). The groups did not differ significantly by gender (59.7% vs. 64.8% female, $\chi^2 = 0.89$, $p = .346$) or course typology (51.3% vs. 60.8% in business/economics, $\chi^2 = 2.89$, $p = .089$). However, university students were significantly more likely to complete both waves than polytechnic students (67.5% vs. 11.2%, $\chi^2 = 99.76$, $p < .001$), likely reflecting institutional differences in course delivery or communication during emergency remote teaching. While attrition was not random with respect to institutional type, it was largely independent of gender and course typology.

Besides examining attrition patterns within the sample, it is also important to situate the composition of each wave in relation to the broader higher-education population. To this end, Table II provides a comparison between the demographic characteristics of the study sample (Wave 1, Wave 2, and the paired subsample) and national higher-education benchmarks published by Directorate-General for Education and Science Statistics (DGEEC).

Insert Table II about here

Although Table II indicates notable departures from national benchmarks in HEI typology and field of study - with Polytechnic and Business & Economics students relatively overrepresented - these patterns are consistent with module-level convenience sampling and expected self-selection into entrepreneurship courses. At the same time, the sample aligns closely with national distributions for gender and age, and the matched two-wave design (paired $n = 154$) preserves the study's capacity to evaluate temporal measurement invariance. Attrition was concentrated among polytechnic students, and Business & Economics students remain overrepresented.

Procedures

Only participants with complete responses to all items in each wave were included in our sample(s). This listwise approach was adopted to preserve the integrity of the item covariance matrix - the foundational input for confirmatory factor analysis and subsequent measurement invariance testing. Given the exceptionally low rate of item-level missing data (affecting fewer than 2% of cases in each wave) and the parsimony of the measurement model, this procedure ensured a transparent and analytically stable dataset without meaningfully reducing the available sample size. Thirty-six Wave-2 responses (19.0% of Wave 2) could not be matched to Wave 1 because participants omitted or entered inconsistent self-generated 4-digit codes; these cases were excluded from the longitudinal analyses (final paired $\mathrm{n} = 154$).

Although the matched longitudinal sample is modest, longitudinal invariance testing is based on repeated measurements from the same individuals (308 total observations across two waves). Moreover, cross-sectional invariance analyses across subgroups require the Wave 1 sample to be split into smaller groups (gender, HEI typology, and course typology), resulting in effective group sizes that are comparable to, or smaller than, the paired longitudinal subsample. The reduced response rate in Wave 2 can reflect the disruption and survey fatigue associated with emergency remote teaching during the onset of the pandemic (Possamai *et al.*, 2022).

Given the parsimonious six-item EI measurement model and the strong fit indices obtained (see 'results' section), the available sample is considered adequate for the present invariance assessment (Kline, 2015). Simulation research indicates that for simple, well-specified models, tests of invariance using changes in comparative fit indices maintain adequate statistical power with samples of 100–150 observations per group (Wolf *et al.*, 2013, Meade *et al.*, 2008).

The short questionnaire was the same in the two periods so that students' EI could be measured pre and post entrepreneurship modules. However, we added two additional items with different purposes at the end of the semester.

First, we added the following ordinal proposition to the questionnaire at the end of the semester to capture the potential effect of the pandemic on students' answers: 'During the semester, your answers were conditioned by the COVID-19 crisis'; the students' options ranged from strongly disagree (one point) to strongly agree (five points).

Second, to enable longitudinal matching while preserving anonymity, we implemented a self-generated identification procedure. At the beginning of the semester (Wave 1), each student was asked to create an anonymous personal 4-digit code and to re-

enter the same code at the end of the semester (Wave 2). This approach allowed responses to be paired across measurement occasions without directly collecting identifying information (e.g., names or email addresses). In Wave 2, we also included a verification question ("Did you complete this questionnaire at the beginning of the semester?") to confirm prior participation and reduce the likelihood of mismatched cases. Only responses with consistent identification codes across both waves were retained in the final matched sample, while observations with missing, incomplete, or non-matching codes were excluded from the longitudinal analyses.

Finally, no outliers were removed as the dataset did not exhibit extreme or influential observations that would justify case-wise deletion, and retaining the full range of responses was considered important to preserve the integrity of the item covariance structure and the representativeness of students' EI. Modification indices were inspected as part of model diagnostics; however, no post-hoc model modifications (e.g., correlated residuals) were introduced as these adjustments were not theoretically motivated and may capitalise on sample-specific variance at the expense of parsimony and replicability (Hermida, 2015, Landis *et al.*, 2009). This conservative approach is particularly warranted in measurement invariance testing, where data-driven modifications may compromise cross-group and longitudinal comparability.

Descriptives

Some trends can be seen in the descriptive statistics depicted in Table III and Table IV for the two-wave online questionnaire.

Insert Table III about here

Insert Table IV about here

In short, and consistent with the reference values defined by George and Mallery (2010)— | Sk | > 2 (marked asymmetry) or | Ku | values > 2 (marked kurtosis), it can be seen from Table III and Table IV that none of the variables seriously violated the univariate normal distribution at either moment.

Multi-group confirmatory factor analysis

We tested the psychometric equivalence of students' EI, more specifically, whether or not the students' EI is invariant across key defined groups and over time. Using maximum likelihood estimation, we therefore applied Multi-group confirmatory factor analysis (MGCFA), which is the traditional method to test measurement invariance (Ding *et al.*, 2023).

To test for measurement invariance using MGCFA, we tested whether the instrument could maintain its factorial structure sufficiently across groups or over time, as in other studies (André *et al.*, 2020, Wood *et al.*, 2021, Brown *et al.*, 2017). MGCFA was then performed primarily by assessing differences in model fit between groups or over time and complementarily by using the χ^2 statistic (through covariance-based structural equation modelling). We followed recommendations that prioritise changes in approximate fit indices (e.g. CFI, RMSEA, SRMR) over χ^2- difference tests, given the well-documented sensitivity of χ^2 to sample size and minor model misspecifications. This approach follows established conventions for simpler models (Cheung and Rensvold, 2002, Chen, 2007), which suit the present study's parsimonious structure and avoid methods typically reserved

for complex or large-scale multigroup analyses (e.g. alignment optimization or Bayesian structural equation modelling) - see Table V.

Insert Table V about here

Mean difference tests

In addition to the measurement invariance tests, whenever non-invariance or weak invariance was found, we adopted the approach taken by Opozda-Suder *et al.* (2021) to analyse the behaviour of the data in terms of mean differences for each item on the six-item EI scale.

Results

Confirmatory Factor Analysis

The total amount of variance that can be explained by the EI factor is 79.93% and 87.28% respectively in the first and second waves of the questionnaire. Therefore, using eigenvalues > 1, only one factor is retained, i.e. students' EI. Table VI shows the main results of CFA in terms of the validity and reliability of students' EI.

Insert Table VI about here

The rule of thumb for interpreting Cronbach's alpha is 0.70 (Cortina, 1993, Nunnally, 1978), although some authors consider values above 0.6 as adequate for social sciences (van Griethuijsen *et al.*, 2015, Taber, 2018). Therefore, the factor revealed great internal consistency at both points in time. The sample adequacy for the factor analysis is

assured by KMO measure, in which both values are above 0.6 at each moment, given the initial cut-off value (0.5) proposed by Kaiser (1974) and suggested more recently (0.6) by Tabachnick and Fidell (2007) and Pallant (2016). The adequacy of data is confirmed by Bartlett's test of sphericity, in which the factor significance level is 0.000 due to the presence of correlations among measurement variables and therefore suitable for factor structure at both moments.

The average variance extracted (AVE) and composite reliability (CR) measures might suggest some trends to evaluate convergent validity and construct reliability. In fact, AVE values should be higher than the minimum threshold of 0.5 (Fornell and Larcker, 1981) and CR values should exceed 0.7 (Hair *et al.*, 2013); if factors cumulatively exceed these thresholds, both convergent validity and construct reliability are achieved (Hair *et al.*, 2005). As we can see, EI assured these criteria at both moments. As the CR of these factors is above the threshold, the internal reliability of the measurement items is acceptable (Lam, 2012). On the other hand, none of the 6 items has standardised regression weights below the acceptable threshold (0.4) (Wülferth, 2013, Hulland, 1999). The assessment of the model fit in CFA based on the index values suggested by Kline (2015) is as follows:

(i) [First wave of questionnaire] $\frac{\chi^2}{df} = 1.892$; RMSEA = .057; CFI = .996; SRMR = .0118

(ii) [Second wave of questionnaire] $\frac{\chi^2}{df} = 1.775$; RMSEA = .071; CFI = .997; SRMR = .0074

In short, the models are a good fit for the data.

Multi-group confirmatory factor analysis

Results are presented in two stages using a common MGCFA framework to assess measurement invariance of students' EI. First, measurement invariance across student subgroups is examined using data collected at the beginning of the semester (Tables VII, VIII, and IX). Second, longitudinal measurement invariance (over time) is analysed using paired responses from the beginning and end of the semester (Table X).

Insert Table VII about here

Insert Table VIII about here

Insert Table IX about here

Insert Table X about here

Tables VII-X confirm configural, metric, and scalar invariance for students' EI across gender, HEI typology, course typology, and over time. Changes in fit indices remained within recommended thresholds, alongside acceptable overall model fit – see Table V. For residual invariance, only the gender model met all recommended cut-off criteria for differences between nested models; however, the models for HEI typology, course typology, and longitudinal invariance did not satisfy these thresholds.

Based on the conventional χ^2 statistic and a significance level of 5%, we cannot reject the null hypothesis that the parameters are equal across all groups, namely for metric invariance [gender: $\chi^2_{dif}(19) = 1.405$, $p = 0.554$; HEI typology: $\chi^2_{dif}(19) = 1.608$, $p = 0.343$; course typology: $\chi^2_{dif}(19) = 1.282$, $p = 0.370$] and scalar invariance [gender:

$\chi^2_{dif}(20) = 1.428$, $p = 0.172$; HEI typology: $\chi^2_{dif}(20) = 1.540$, $p = 0.630$; course typology: $\chi^2_{dif}(20) = 1.262$, $p = 0.347$] – see Tables VII-IX. Using the same approach for measurement invariance over time, we cannot reject the null hypothesis that the parameters are equal for metric invariance [$\chi^2_{dif}(59) = 1.117$, $p = 0.250$] and for scalar invariance [$\chi^2_{dif}(65) = 1.152$, $p = 0.188$], as depicted in Table X.

Considering both χ^2 - difference tests and changes in fit indices, configural, metric, and scalar invariance of students' EI were supported across gender, HEI typology, course typology, and over time; residual invariance was not consistently achieved. As longitudinal scalar invariance was established, comparisons of latent means for EI across waves are psychometrically valid, supporting the interpretation of EI stability over the semester; similarly, scalar invariance across gender, HEI typology, and course typology justifies the comparison of latent EI means between these subgroups.

In addition, and assuming data are normally distributed based on summary descriptives at both points in time, we performed a Paired-Samples T Test to glean a better understanding of each EI item. Table XI compares the mean of students' EI at the beginning and end of the semester.

Insert Table XI about here

Table XI shows that Paired-samples t-tests indicated no significant differences in EI items before and after the entrepreneurship modules ($p > .05$), reinforcing longitudinal stability.

Finally, Figure 1 presents the histogram for the ordinal proposition completed by the students in the second wave of the questionnaire: 'During the semester, your answers

were conditioned by the COVID-19 crisis', with the students' options ranging from strongly disagree (one point) to strongly agree (five points).

Insert Figure 1 about here

Figure 1. Histogram with the distribution of students' responses

With a mean and median of around four points, the evidence shows that the contextual environment of the pandemic significantly influenced students' responses.

Discussion

Overall, strong measurement invariance was met across groups and over time, confirming hypotheses H1, H2, and H3. By contrast, strict (residual) invariance was only achieved for gender groups and not for HEI typology, course typology, or over time; hence, hypothesis H4 is only partially supported. This evidence suggests that some item-specific residual variances may differ across conditions, but this does not affect the interpretation of latent constructs and their relationships (Putnick and Bornstein, 2016); thus, our substantive conclusions remain robust as strong invariance is met.

From a contextualist perspective, the pandemic may have acted as a shared macro-environment that temporarily aligned students' perceptions of risk, constraints, and opportunity, thereby reducing the explanatory power of traditional subgroup differences (Kuckertz *et al.*, 2020, Bavel *et al.*, 2020). Within the framework of TPB, EI antecedents (attitudes, norms, perceived control) evolve gradually and can therefore yield inherent temporal durability even amid disruptions, while macro-shocks limit short-term shifts and cross-group differentiation (Joensuu-Salo *et al.*, 2020, Belchior and Lyons, 2023).

Regarding TDE framework, digital platforms tend to standardise the entrepreneurial landscape (uniform tools, low barriers) and therefore might favour structural homogeneity and measurement equivalence across diverse students despite implementation challenges like the digital divide (Duong *et al.*, 2024, Ulhøi, 2021, Zhao *et al.*, 2025).

On the other hand, cross-group invariance provides greater confidence when comparing EI across diverse student cohorts, particularly given ongoing evidence of gender and context-related differences in EI (Zakaria *et al.*, 2024, Köpke and Schmitt-Rodermund, 2025, Passavanti *et al.*, 2024). Conversely, the weaker longitudinal scalar invariance may reflect shifting response thresholds over time as students cognitively appraise entrepreneurial futures under heightened uncertainty and emotional strain, which can influence how intention-related items are endorsed during crisis periods (Fetzer *et al.*, 2021, Pyszczynski *et al.*, 2021). Finally, although residual (strict) invariance was not supported, this outcome is not uncommon in applied multi-group and longitudinal research, as equality of item residuals represents a highly restrictive condition that is often difficult to satisfy in practice (Putnick and Bornstein, 2016).

Overall, the findings highlight both the robustness of the EI measurement model across groups and the possibility that the underlying theoretical framework may constrain short-term changes in students' EI during pervasive crises. Students' acknowledgment of the pandemic's significant influence on their EI, as captured in the questionnaire (see Figure 1), provides empirical support for the contextualist perspective on entrepreneurship. This aligns with foundational work such as Welter (2011), Autio *et al.* (2014) or Hindle (2010), as well as more recent contributions from contextualists like Ben-Hafaïedh *et al.* (2024) and Thomassen *et al.* (2019), particularly in educational settings.

Practical implications

From an educational perspective, these results reinforce arguments that the effects of entrepreneurship education depend strongly on pedagogical design and experiential intensity (Nabi *et al.*, 2017), and they may be less pronounced when learning is delivered under crisis-related disruptions such as emergency remote teaching and heightened contextual uncertainty (Vecchiarini *et al.*, 2024, Ribeiro *et al.*, 2020).

The lessons learned should be examined so that higher education can prepare an effective response to any future pandemics, particularly in entrepreneurship modules (Shadbolt *et al.*, 2022). To prepare for future emergencies, HEIs should implement the following crisis-resilient pedagogical strategies that maintain experiential quality under disruption:

(i) deploy interactive digital simulations enabling students to experiment with entrepreneurial decision-making under uncertainty in virtual environments (Zulfiqar *et al.*, 2021); (ii) establish structured virtual mentorship networks connecting students with practicing entrepreneurs through technology-mediated platforms, aligning with digital entrepreneurship ecosystems (Secundo *et al.*, 2021, Nambisan *et al.*, 2019); (iii) integrate resilience frameworks explicitly into curricula, teaching opportunity identification amid disruption and rapid business model pivoting (Crawford, 2023, Branicki *et al.*, 2017); (iv) design asynchronous collaborative entrepreneurial projects using digital project management tools to maintain team-based experiential learning when synchronous interaction is constrained (O'Connor *et al.*, 2021); and (v) adopt digital entrepreneurship pedagogy that teaches students to leverage digital platforms for opportunity recognition, customer discovery, and market validation (Sitaridis and Kitsios, 2023).

These crisis-resilient pedagogical strategies can be adapted by HEIs in other countries that face sudden disruptions (e.g. pandemics, conflicts, climate-related events), provided they rely on comparable digital infrastructures and entrepreneurship curricula.

Theoretical implications

Context is of the utmost importance to the entrepreneurship process (Welter *et al.*, 2019); indeed, the invariance measurement of students' EI was confirmed in the pandemic scenario. This is particularly relevant to the theoretical background as a number of previous studies reported differences in students' EI across the defined key groups (gender, HEI typology, course typology). Although our data come from one Portuguese region, the mechanisms we identify - crisis-driven contextual convergence, TPB and EI based stability, and platform-driven homogenisation - are likely to operate in higher education systems that experienced similar pandemic disruptions and rapid digitalisation, thereby offering a transferable lens for interpreting EI research in other national contexts.

Our findings extend contextualist entrepreneurship theory (Welter, 2011, Autio *et al.*, 2014) to crisis contexts, demonstrating that extreme environmental disruptions can temporarily override traditional EI moderators. This contributes to emerging theory on crisis-driven contextual convergence, where shared constraints create psychometric equivalence across groups that typically differ significantly (Kuckertz *et al.*, 2020, Liguori and Pittz, 2020).

The temporal stability of EI during disruption connects to resilient entrepreneurship frameworks (Korber and McNaughton, 2017), which conceptualise entrepreneurial cognition as maintaining structural coherence under environmental shocks while remaining

contextually responsive. Our measurement invariance evidence supports this theoretical duality: psychometric stability coexisting with contextual sensitivity.

Additionally, our findings contribute to the TDE (Nambisan, 2017, Sussan and Acs, 2017) by demonstrating that, while technology-mediated education delivery can facilitate knowledge transfer during crises, it struggles to replicate experiential learning, which influences intention formation. This suggests digital platforms require pedagogical redesign to effectively develop entrepreneurial cognition, not merely content transfer.

By empirically establishing EI measurement invariance across key subgroups and over time in a crisis setting, we validate EI comparisons - a previously untested assumption. This extends measurement theory into turbulent contexts (Vandenberg and Lance, 2000), enabling future crisis-context entrepreneurship research. In fact, ‘researching entrepreneurship in its contexts is not only about recognising the complexity and diversity of the phenomenon and its contexts for theory and methodology as such, but it is also about listening to each other and recognising contributions outside the mainstream debate’ (Welter, 2011, p. 178).

By empirically establishing EI measurement invariance across key subgroups and over time in a crisis setting - a condition that prior pandemic EI studies typically assume but do not test - this study closes a critical methodological gap and refines theory on how context shapes entrepreneurial cognition during systemic shocks.

Concluding remarks

This study examined the measurement invariance of students' EI in Portuguese HEIs across key demographic groups and over time, drawing on two waves of data collected during the pandemic. Our findings suggest that the pandemic context influenced students' EI

responses, indicating that situational factors may shape EI measurement in higher education settings. Considering this evidence along with the profound impact of the pandemic on our society (Khalifa *et al.*, 2021) as well as the risk and uncertainty common to entrepreneurship (Audretsch *et al.*, 2022), the context can be seen as a plausible explanation for the measurement invariance observed in students' EI. Moreover, both TPB and TDE contribute to this invariance result as TPB underscores the gradual evolution of stable EI antecedents (Ajzen, 1991), while TDE posits standardised platforms that reduce cross-group variability (Nambisan, 2017). These findings suggest that crisis context, together with TPB-based stability and digital platform homogenisation, helps explain the observed psychometric equivalence of EI.

As with all research, this study is not without its limitations. First, attrition between waves reduced the sample size, precluding simultaneous measurement invariance testing across groups and waves. Attrition was non-random with respect to institutional type, potentially reflecting differential engagement during emergency remote teaching. Second, convenience sampling from eight HEIs in Portugal's Central Region limits external validity, as the sample deviates from national benchmarks in HEI typology and field of study; self-selection bias cannot be excluded, as students enrolling in entrepreneurship modules may differ systematically from the broader student population. Third, the single-semester timeframe may be insufficient to detect meaningful changes in EI, given the psychological disruptions associated with emergency remote teaching and the extended exposure likely required for educational interventions to produce measurable effects. Notably, these constraints do not compromise the primary objective of the study, as measurement invariance testing evaluates construct structure rather than population-level estimates.

In future research, it would be useful to test the measurement invariance of students' EI simultaneously across groups and over time. It would also be fruitful to test the measurement invariance of students' EI across other academic groups enrolled in entrepreneurship modules, such as graduates, or at the regional level. Future research should routinely report responder versus non-responder comparisons and conduct post-hoc power and sensitivity analyses for paired samples to clarify minimum detectable effects and the robustness of null findings. Where feasible, researchers should apply adjustment techniques (for example, propensity-weighting) and adopt stratified or probability sampling across institutional types and regions, complemented by multi-site replications and quasi-experimental or matched-cohort designs, to assess and correct for selection and attrition biases and thereby strengthen external validity. Finally, more advanced techniques such as alignment optimisation or Bayesian SEM could further probe invariance patterns.

Table I. Sample composition by group and time

Moment	Gender (n)	HEI typology (n)	Course typology (n)	Total n
Beginning of semester	Female: 173; Male: 106	Polytechnic: 161; University: 118	Business & Economics: 155; Other: 124	279
End of semester	Female: 113; Male: 77	Polytechnic: 54; University: 136	Business & Economics: 82; Other: 108	190
Paired responses (end)	Female: 92; Male: 62	Polytechnic: 50; University: 104	Business & Economics: 79; Other: 75	154

Source: Authors own work

Table II. Demographic Comparison Between Sample and Population (Wave 1, Wave 2, and Paired Sample)

Variable	Wave 1 Sample (n = 279)	Wave 2 Sample (n = 190)	Paired Longitudinal Sample (n = 154)	Population Benchmark	Notes
Gender – Female	173 (62.0%)	113 (59.5%)	92 (59.7%)	**54%**	Slightly higher female representation than national average.
Gender – Male	106 (38.0%)	77 (40.5%)	62 (40.3%)	**46%**	Stable proportions across waves.
HEI typology – Polytechnic	161 (57.7%)	54 (28.4%)	50 (32.5%)	**37%**	Strong attrition among polytechnic students in Wave 2.
HEI typology – University	118 (42.3%)	136 (71.6%)	104 (67.5%)	**63%**	University students more likely to complete Wave 2.
Course typology – Business & Economics	155 (55.6%)	82 (43.2%)	79 (51.3%)	**26.4%**	Business & Economics students are substantially overrepresented.
Course typology – Other fields	124 (44.4%)	108 (56.8%)	75 (48.7%)	**73.6%**	Expected, given entrepreneurship modules often attract Business & Economics students.
Age – up to 24 years	88%	91%	90%	**82.6%**	Sample is slightly younger than national average.

Source: Authors own work and data from the DGEEC, academic year 2024/2025

Table III. Descriptive statistics at the beginning of the semester

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
EI.1_t1	1	5	3.52	1.105	-.403	-.478
EI.2_t1	1	5	3.21	1.097	-.247	-.452
EI.3_t1	1	5	3.20	1.122	-.149	-.556
EI.4_t1	1	5	3.25	1.132	-.191	-.691
EI.5_t1	1	5	2.98	1.195	.060	-.800
EI.6_t1	1	5	3.19	1.200	-.125	-.823
Valid N	279					

Source: Authors own work

Table IV. Descriptive statistics at the end of the semester

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
EI.1_t2	1	5	3.21	1.010	-.288	-.297
EI.2_t2	1	5	2.89	1.058	.089	-.715
EI.3_t2	1	5	2.93	1.121	.255	-.637
EI.4_t2	1	5	2.97	1.193	.261	-.901
EI.5_t2	1	5	2.79	1.136	.499	-.542
EI.6_t2	1	5	2.95	1.203	.215	-.953
Context	1	5	4.02	.852	-.874	1.091
Valid N	154					

Source: Authors own work

Table V. Summary of common fit criteria for testing configural, metric, scalar, and residual invariance

Invariance Level	Definition	Assessment / Rules of Thumb	Purpose / Interpretation
Configural	Same factor structure across groups; no equality constraints	CFI ≥ 0.90 (good), ≥ 0.95 (excellent) RMSEA ≤ 0.08 (adequate), ≤ 0.05 (good); SRMR ≤ 0.08	Checks whether the construct has the same conceptual meaning across groups
Metric (Weak)	Factor loadings equal across groups	[Compare to configural model] ΔCFI ≤ 0.01; ΔRMSEA ≤ 0.015; ΔSRMR ≤ 0.03	Ensures constructs are measured on the same scale; allows comparison of relationships between latent variables
Scalar (Strong)	Factor loadings and intercepts equal	[Compare to metric model] ΔCFI ≤ 0.01; ΔRMSEA ≤ 0.015; ΔSRMR ≤ 0.01	Required for comparing latent means
Residual (Strict)	Factor loadings, intercepts, and residual variances equal	[Compare to scalar model] ΔCFI ≤ 0.01; ΔRMSEA ≤ 0.015; ΔSRMR ≤ 0.01	Ensures observed scores are fully comparable across groups

Source: Cheung and Rensvold (2002); Chen (2007)

Table VI. Validity and reliability of CFA

Factor and measurement variables (beginning of the semester)	**α[2]**	**KMO[3]**	**BT[4]**	**AVE[5]**	**CR[6]**	**SRW[7]**	**SMC[8]**
Entrepreneurial Intention (EI)							
EI.1_t1 - I'm ready to do anything to be an entrepreneur						.547	.334
EI.2_t1 - My professional goal is to become an entrepreneur						.757	.557
EI.3_t1 - I will make every effort to start and run my own firm	.932	.903	.000	.705	.933	.858	.717
EI.4_t1 - I'm determined to create a firm in the future						.916	.841
EI.5_t1 - I have very seriously thought of starting a firm						.924	.854
EI.6_t1 - I have the firm intention to start a firm some day						.946	.912
Factor and measurement variables (end of the semester)	**α**	**KMO**	**BT**	**AVE**	**CR**	**SRW**	**SMC**
Entrepreneurial Intention (EI)							
EI.1_t2 - I'm ready to do anything to be an entrepreneur						.810	.656
EI.2_t2 - My professional goal is to become an entrepreneur						.861	.741
EI.3_t2 - I will make every effort to start and run my own firm	.971	.917	.000	.846	.970	.941	.885
EI.4_t2 - I'm determined to create a firm in the future						.977	.955
EI.5_t2 - I have very seriously thought of starting a firm						.956	.914
EI.6_t2 - I have the firm intention to start a firm some day						.961	.924

Source: Authors own work

[2] Cronbach's Alpha
[3] Kaiser-Meyer-Olkin test
[4] Bartlett's test of sphericity (significance value)
[5] Average Variance Extracted
[6] Composite Reliability
[7] Standardised Regression Weights
[8] Squared Multiple Correlations

Table VII. Measurement invariance tests comparing invariance across gender groups

Models	χ^2/df	CFI	RMSEA	SRMR	Comparison	*P*-value	$\Delta\chi^2/df$	ΔCFI	$\Delta RMSEA$	$\Delta SRMR$
MI1. Configural	22.729 (14) 1.624	.994	.047	.014						
MI2. Metric	26.699 (19) 1.405	.995	.038	.031	MI1	.554	-.219	.001	-.009	.017
MI3. Scalar	28.560 (20) 1.428	.994	.039	.026	MI2	.172	.023	-.001	.001	-.005
MI4. Residual	45.979 (28) 1.642	.988	.048	.032	MI3	.026	.214	-.006	.009	.006

Source: Authors own work

Table VIII. Measurement invariance tests comparing invariance across HEI typology

Models	χ^2/df	CFI	RMSEA	SRMR	Comparison	*P*-value	$\Delta\chi^2/df$	ΔCFI	$\Delta RMSEA$	$\Delta SRMR$
MI1. Configural	24.918 (14) 1.780	.993	.053	.014						
MI2. Metric	30.560 (19) 1.608	.992	.047	.038	MI1	.343	-.172	-.001	-.006	.023
MI3. Scalar	30.792 (20) 1.540	.993	.044	.043	MI2	.630	-.068	.001	-.003	.005
MI4. Residual	53.448 (28) 1.909	.983	.057	.062	MI3	.004	.369	-.010	0.013	.019

Source: Authors own work

Table IX. Measurement invariance tests comparing invariance across course typology (business/economic courses vs other courses)

Models	χ^2/df	CFI	RMSEA	SRMR	Comparison	*P*-value	$\Delta\chi^2/df$	ΔCFI	$\Delta RMSEA$	$\Delta SRMR$
MI1. Configural	18.962 (14) 1.354	.997	.036	.012						
MI2. Metric	24.352 (19) 1.282	.996	.032	.026	MI1	.370	-.072	-.001	-.004	.014
MI3. Scalar	25.238 (20) 1.262	.997	.031	.034	MI2	.347	-.020	.000	-.001	.008
MI4. Residual	48.174 (28) 1.721	.987	.051	.051	MI3	.003	.459	-.010	.020	.017

Source: Authors own work

Table X. Measurement invariance tests comparing invariance over time (beginning of the semester vs end of the semester)

Models	χ^2/df	CFI	RMSEA	SRMR	Comparison	*P*-value	$\Delta\chi^2/df$	ΔCFI	$\Delta RMSEA$	$\Delta SRMR$
MI1. Configural	64.159 (53) 1.211	.965	.037	.052						
MI2. Metric	65.912 (59) 1.117	.979	.028	.055	MI1	.250	-.284	-.014	.009	-.003
MI3. Scalar	74.889 (65) 1.152	.969	.031	.060	MI2	.188	.035	.010	-.003	-.005
MI4. Residual	150.211 (71) 2.116	.754	.085	.108	MI3	.000	.964	.215	-.054	-.048

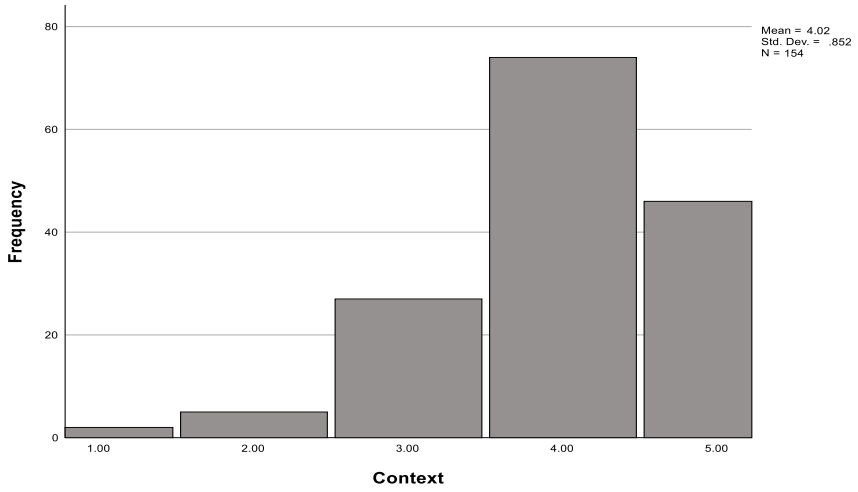
Source: Authors own work

Table XI. Paired samples T-test

Pairs	Differences	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	EI.1_t1 - EI.1_t2	0.104	1.456	0.117	-0.128	0.336	0.886	153	0.377
Pair 2	EI.2_t1 - EI.2_t2	0.234	1.571	0.127	-0.016	0.484	1.847	153	0.067
Pair 3	EI.3_t1 - EI.3_t2	0.201	1.658	0.134	-0.063	0.465	1.506	153	0.134
Pair 4	EI.4_t1 - EI.4_t2	0.227	1.732	0.14	-0.048	0.503	1.628	153	0.106
Pair 5	EI.5_t1 - EI.5_t2	0.071	1.7	0.137	-0.199	0.342	0.521	153	0.603
Pair 6	EI.6_t1 - EI.6_t2	0.136	1.775	0.143	-0.146	0.419	0.953	153	0.342

Source: Authors own work

Figure 1.



Appendix A. Technical specifications: sampling, response rates, matching and missing-data rules (authors' information)

Item	Details
Sampling frame	Undergraduate students enrolled in entrepreneurship modules at 7 HEIs in Centro Region (3 universities; 4 polytechnic institutes).
Sampling method	Convenience sampling (module instructors distributed survey via Moodle).
Recruitment channel	Moodle course pages; Google Forms questionnaire.
Inclusion criteria	Enrolled in an entrepreneurship module during the semester; completed all questionnaire items at a given wave.
Exclusion criteria	Incomplete questionnaires; inconsistent or missing self-generated 4-digit codes for matching.
Wave 1 valid responses	**n = 279**
Wave 2 valid responses	**n = 190**
Paired (matched) responses	**n = 154** (55.2% of Wave 1; 81.1% of Wave 2)
Matching procedure	Self-generated anonymous 4-digit code created in Wave 1 and re-entered in Wave 2; verification question in Wave 2.
Matching losses	36 unmatched Wave 2 responses = 19.0% of Wave 2; paired retention = 154/279 = 55.2% of Wave 1
Missing-data rule	Listwise deletion (only complete cases retained for each analysis).
Response rate notes	No formal sampling frame for population inference; response rates reported as raw counts and paired-match proportion.
Software	IBM SPSS Amos v26 (MGCFA); R v4.3.2 (longitudinal analyses).
Purpose of sampling	Assess psychometric equivalence (measurement invariance) rather than estimate population parameters.

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