



The role of emotions in entrepreneurship and employability: A different approach of the theory of planned behaviour through neuroentrepreneurship

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ABSTRACT

This study examines how positive emotions elicited by an entrepreneurial education programme influence university students' entrepreneurial intention and self-perceived employability, in order to ascertain how affective states shape career-related decisions in higher education. An empirical research was conducted with 117 marketing and market research students from a Spanish public university who participated in two innovative entrepreneurship training activities. Emotions were captured through a neuroscience-based Emotion AI system using convolutional neural networks, while entrepreneurial intention, perceived behavioural control, social norms, personal attitudes and employability were measured using a theory of planned behaviour questionnaire administered before and after the activities, and the proposed model was estimated using the partial least squares path modelling (PLS-SEM) method. This method was employed due to its suitability for exploratory models and complex relationships. The results indicate that positive emotions significantly increase perceived behavioural control, which in turn reinforces entrepreneurial intention and, ultimately, students' perceived employability. The study contributes to link entrepreneurial intention and employability using neuroscientific tools unlike previous studies. Additionally, it provides practical guidance for designing entrepreneurship programmes that deliberately evoke positive emotions and promote soft skills.

1. Introduction

In recent years, the role of emotions in entrepreneurship has acquired significant attention owing to its impact on the identification of business opportunities or on the predisposition to set up a business. Entrepreneurship, a key driver of economic and social development, is influenced by educational interventions aimed at enhancing entrepreneurial competencies (Chell, 2001; Drucker, 1985; Fayolle & Gailly, 2015; GEM Global, 2024; Laguna-Sánchez et al., 2020; Schumpeter, 1934). Recent reports emphasise the need for educational interventions that develop not only technical and managerial skills but also the socio-emotional dimensions that promote students' career-related decision-making and perceived employability (Ayala Calvo & Manzano García, 2021; GEM Global, 2024; Juarez-Varon et al., 2024; Zuluaga et al., 2025). The theory of planned behaviour (TPB) (Ajzen,

1991), which focusses on personal attitudes (PA), social norms (SN) and perceived behavioural control (PBC), serves as a predominant framework in this field (Bae et al., 2014; Fayolle & Gailly, 2015; Liñán & Chen, 2009). Recent studies highlight the impact of entrepreneurship education on employability, suggesting that entrepreneurial skills enhance job prospects (Ayala Calvo & Manzano García, 2021; Eid et al., 2017; Pitan & Muller, 2020). Therefore, an emerging strand of literature highlights the relevance of employability as a complementary outcome of entrepreneurship education, suggesting that entrepreneurial competences can enhance graduates' perceived ability to obtain and maintain qualified employment (Ayala Calvo & Manzano García, 2021; Eid et al., 2017; Laguna-Sánchez et al., 2020; Magd & Kunjumammed, 2024; Nguyen & Nguyen, 2023; Pardo-García & Barac, 2020). Likewise, the innovation and experimental learning applied to entrepreneurial programmes is a line that is incorporated to better develop this topic (Fayolle & Gailly,

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2008; Perez-Macias et al., 2023; Taneja et al., 2024).

Moreover, several researchers have proposed integrating cognitive and affective processes into the TPB to provide a more comprehensive understanding of entrepreneurial decision-making (Bagozzi et al., 2003; Foo, 2011; Grégoire et al., 2015). Positive emotions, such as happiness and hope, have been shown to facilitate entrepreneurial intention (EI) by enhancing PBC and decision-making processes (Fredrickson, 2001; Leith & Baumeister, 1996). Thus, previous studies have mainly focussed on showing that positive and negative effects influence opportunity recognition, risk perceptions and persistence, as well as a range of soft skills associated with entrepreneurial behaviour (Bonesso et al., 2018; Lackeus, 2014a; Serna-Zuluaga et al., 2024). Yet, despite this recognition, relatively few studies have systematically integrated affective processes into the TPB framework to provide a more holistic explanation of EI and related outcomes such as employability. In this scenario, it is also necessary to consider the capacity of neuroscience, an emerging field that leverages neuroscientific tools to study the entrepreneurial process and offers novel insights into the affective dynamics of entrepreneurship (de Holan, 2014; Juarez-Varon et al., 2024; Nicolaou & Shane, 2014; Sharma et al., 2021a; Zuluaga et al., 2025).

Despite extensive research on the cognitive aspects of entrepreneurship, the specific role of emotions in EI and employability remains vague. The present study attempts to address this knowledge gap. While previous studies have acknowledged the influence of emotions on entrepreneurial motivation and decision-making, empirical investigations incorporating neuroscientific methods remain scarce (Hayton & Cholakova, 2012; Krueger & Day, 2010; Massaro et al., 2023). This gap is particularly evident in the context of entrepreneurship education, where the impact of emotions on learning outcomes and EI remains underexplored. In this context, neuroentrepreneurship proposes the integration of neuroscience tools into entrepreneurship research to advance knowledge about how affective and cognitive processes jointly shape entrepreneurial behaviour. This research applies neuroscience-based tools in entrepreneurship education and links these tools to employability-related outcomes, thereby addressing this gap in the current literature (Juarez-Varon et al., 2024).

This study aims to fill this gap by examining how emotions elicited during entrepreneurship training activities influence EI and self-perceived employability. Accordingly, the following research questions are addressed:

RQ1. To what extent do positive emotions elicited during entrepreneurship education programmes influence university students' PBC and EI?

RQ2. Does EI, as specified by the TPB, relate to students' self-perceived employability after participating in entrepreneurship education activities?

RQ3. To what extent does the integration of neuroscientific measures of emotion provide additional insights into the relationships between emotions, EI and employability in the context of higher education?

This study introduces a neuroentrepreneurship perspective by utilising neuroscience methodologies and applying the partial least squares path modelling (PLS-SEM) method to a proposed model that provides a novel view of the interplay between emotions and entrepreneurial behaviour. Two main insights can be emphasised. First, it reveals the connection between EI and employability and underlines the relevance of self-efficacy, understood as feeling more capable of 'doing things', either becoming an entrepreneur or getting a job, thus reinforcing the role of PBC. Second, it integrates affective processes into the TPB framework to offer a more holistic understanding of the impact of entrepreneurship education. This approach not only advances the existing theoretical knowledge but also provides practical implications for designing effective entrepreneurial education programme.

The remainder of this article is structured as follows. First the theoretical framework on entrepreneurship education, the TPB, emotions and neuroentrepreneurship is presented. The subsequent section discusses the methodology, data collection and the proposed model.

Next, the empirical results are reported and discussed. Finally, the article outlines the main theoretical and practical implications, acknowledges the study's limitations and suggests avenues for future research.

2. Theoretical framework

2.1. Entrepreneurship and education

Throughout history, entrepreneurship has aroused the interest of both academics and political decision-makers owing to its impact on the socio-economic development of nations (Chell, 2001; Davidsson, 2016; Drucker, 1985; GEM Global, 2024; Goel & Joshi, 2017; Schumpeter, 1934). Its influence transcends mere economic growth, that is, employment, encompassing innovation, sustainability, among others (GEM Global, 2024; Shane, 2000). In this context, universities have assumed a central role through education and research on entrepreneurship and have been recognised as key actors in the 'entrepreneurial university' within the triple helix model (Etzkowitz & Leydesdorff, 1995; Etzkowitz et al., 2000; Fayolle et al., 2016). Accordingly, universities have been devoting efforts to design an entrepreneurial education programme based on empirical evidence regarding their potential impact on EI (Bae et al., 2014; Fayolle et al., 2016; Iglesias-Sánchez et al., 2016; Liñán & Chen, 2009; Magd & Kunjumammed, 2024). Competence training is considered an effective tool to enhance the predisposition to entrepreneurship (Iglesias-Sánchez et al., 2019; Laguna-Sánchez et al., 2020; Linan, 2008; Pardo-García & Barac, 2020). More recently, several studies have highlighted the implications of entrepreneurial skills for employability, positioning employability as among the latest lines of development in this field (Ayala Calvo & Manzano García, 2021; Eid et al., 2017; Kolvereid, 1996; Machin & McNally, 2007; Magd & Kunjumammed, 2024; Nguyen & Nguyen, 2023; O'Leary, 2017; Pitan & Muller, 2020; Santos-Jaén et al., 2022; Taneja et al., 2024; Vargas et al., 2018).

The approach to this phenomenon has been largely based on one of the most widespread models in this literature: the TPB (Ajzen, 1991)—the predominant theoretical framework for explaining EI (Bae et al., 2014; Fayolle & Gailly, 2008; Kumar & Das, 2019; Liñán & Chen, 2009; Martínez-González et al., 2019; Ukil et al., 2025; Wach et al., 2021). This theoretical approach is built on three main factors: PA, SN and PBC, understood as one's confidence in their ability to successfully set up a business. These three factors have a direct impact on EI. Recent works extend the model by explicitly incorporating employability as an outcome influenced by EI; recent research introduces employability affected by EI (Ayala Calvo & Manzano García, 2021; Laguna-Sánchez et al., 2020; Pardo-García & Barac, 2020; Santos-Jaén et al., 2022). Consistent with the TPB framework, a different configuration of mediating or moderating effects between EI and employability has been examined to test for more robust relationships among educational interventions, intention and career-related outcomes. According to the initial proposal of Krueger and Carsrud (1993), which is supported by numerous researchers (Aloulou, 2016; Engle et al., 2010; López-Delgado et al., 2019; Pan et al., 2025; Uddin et al., 2022), SN influence EI primarily through PA, not independently.

TPB-based research indicates that educational intervention leads to increased willingness and ability to act entrepreneurially (Fayolle & Gailly, 2015; Iglesias-Sánchez et al., 2019; Lackeus, 2014a; Pardo-García & Barac, 2020). Consequently, considering TPB as the predominant theoretical framework for determining the efficacy of entrepreneurship educational programmes, the following hypotheses are proposed:

H1.a. Personal Attitudes have a positive relationship with Entrepreneurial Intention.

H1.b. Social Norms positively affect Personal Attitudes.

H1.c. Social Norms positively affect Entrepreneurial Intention through Personal Attitudes

H1.d. Perceived Behavioural Control positively influences Entrepreneurial Intention

H2. Entrepreneurial Intention increases the effect on Employability

2.2. Cognitive and affective processes in entrepreneurial intention

Ajzen's TPB is increasingly applied in entrepreneurship research. However, there exist a few theoretical proposals that complement or qualify some of the basic considerations of this traditional model. The most important of these is the theory of effortful decision-making by Bagozzi et al. (2003), which goes beyond relating attitudes to intention and explicitly incorporates cognitive and emotional evaluation processes as central mechanisms in intentional behaviour. Its novelty lies in introducing the cognitive and emotional processes of evaluation as elemental to any meaningful human decision-making process. The emotional component is increasingly significant in explaining the phenomenon of entrepreneurship, given its role in assessing opportunity evaluation, risk perceptions and even in soft skills closely related with entrepreneurs as resilience, motivation, stress management and communication (Foo, 2011; Grégoire et al., 2015; Lackeus, 2014b; Ukil et al., 2025). Nevertheless, studies incorporating affective processes to provide a holistic explanation of entrepreneurial predisposition and the decision-making process linked to entrepreneurship in general remain scarce (Grégoire et al., 2015; Hayton & Cholakova, 2012; Krueger & Day, 2010; Massaro et al., 2023; Pan et al., 2025; Ukil et al., 2025; Vesci et al., 2024). Consequently, the challenge lies in integrating the influence of affective states with cognitive frameworks to better understand EI (Foo, 2011; Hayton & Cholakova, 2012; Pan et al., 2025; Vesci et al., 2024; Welpe et al., 2012). An integrative approach should include an emotional lens and recognise the significance of emotions in learning (Lackeus, 2014b). Decision-making in an uncertain environment, with exposure to consequent risks, is usual for entrepreneurs. This involved 'emotional charge' induces entrepreneurial behaviour in which cognition and affection are integrated (Hayton & Cholakova, 2012; Shepherd & Cardon, 2009). In fact, according to Stevenson and Jarillo (2007), entrepreneurs guide their decisions by reason and heart.

Emotions have positive or negative valence. The former include happiness and hope; fear, sadness and anger represent the latter. Psychological studies suggest that positive emotions generally lead to the recall of positive information and optimistic evaluations, whereas negative emotions tend to trigger the recall of negative information and pessimistic assessments (Carver, 2003; Drenfeld & Roberts, 2006; Schwarz & Clore, 2003). The influence is evidenced in the capacity to take—or avoid—risks (Leith & Baumeister, 1996) and innovate (Foo, 2011; Fredrickson, 2001). As suggested by the evolutionary and psychobiological interpretations of affective regulation processes, negative affect is associated with behavioural inhibition (avoidance or prevention focus) and positive affect is associated with behavioural facilitation (approach or promotion focus) (Watson et al., 1999). Extending these findings to the entrepreneurship domain, several authors suggest that the formation of EI may also be conditioned by the experience of positive or negative emotions during an entrepreneurial education programme.

Existing empirical evidence indicates the influence of emotions and emotional states on the psychology of entrepreneurship. Some studies employ brain imaging analysis to ascertain the conditions under which specific emotional activities are linked to key aspects of entrepreneurship, such as opportunity detection or risk management (Schultz et al., 2008). The consequences are far-reaching, impacting perceptions, intentions and behaviour in an almost unconscious manner that affects memory, judgement or assessment of scenarios, decisions, negotiation processes or social relationships established in these contexts (Forgas & George, 2001; Forgas, 1995). Other works evidence the significant influence of emotions on entrepreneurial motivations (Cardon et al., 2009; Foo, 2011) and even on these through education (Schutz & Pekrum, 2007; Taneja et al., 2024). Despite these contributions, relevant reviews conclude that empirical studies explicitly linking emotions, TPB

constructs and EI remain scarce, especially in educational settings. Furthermore, very few studies have applied neuroscience to elucidate this object of study, and even fewer studies have attempted to explore how entrepreneurship education actions affect EI through emotions.

Now, pertaining to the issue of the capacity of specific emotions in entrepreneurial action, it is possible to highlight several research works (Baron, 2000, 2004; Grégoire et al., 2015; Pan et al., 2025; Randolph-Seng et al., 2015; Ukil et al., 2025). Emotions such as attention, creativity, fear, anger and happiness have been academically explored (Foo, 2011; Krueger & Day, 2010; Lackeus, 2014b; Naqvi et al., 2006; Vesci et al., 2024; Welpe et al., 2012). Grégoire et al. (2015) link the affective dynamics—recognising the role of fear—with entrepreneurship intuition, opportunity evaluation and entrepreneurial team cognition. Meanwhile, Ward (2004) investigates attention and creativity. In line with these works and given our interest in understanding how entrepreneurship education shapes students' cognitions and intentions, this study focuses on positive emotions and their relationship with TPB constructs. Based on literature, positive emotions have been chosen for this study connecting with TPB model. In fact, according to Pech and Cameron (2006), emotions can link with self-efficacy and attitudes associated with entrepreneurs. Accordingly, the following hypotheses are proposed:

H3.a Positive emotions influence cognition of entrepreneurship, understood as Perceived Behavioural Control

H3.b Positive emotions affect Entrepreneurial Intention through Perceived Behavioural Control

H3.c Perceived Behavioural Control and Entrepreneurial Intention sequentially mediate the relationship between positive emotions and Employability

2.3. Challenges in implementing neuroscience in entrepreneurship studies

The consensus on the impact of affective appraisals and emotions experienced during the entrepreneurial process are precisely those that increase the number of advocates for introducing neuroscience into the study of entrepreneurship (Drover et al., 2017; Krueger & Day, 2010; Sharma et al., 2021a). In fact, Foo (2011) stated a decade ago that as emotions may affect opportunity evaluation, they should be included in entrepreneurship research. Currently, neuroscience is a perfect 'candidate' for this challenge (Juarez-Varon et al., 2024; Sharma et al., 2021b). Drawing on methods such as electroencephalography (EEG), functional magnetic resonance imaging (fMRI) and functional near-infrared spectroscopy (fNIRS), neuroscience offers tools to observe the brain and physiological correlates of cognition and affect during entrepreneurial tasks (Bear et al., 2020; Massaro et al., 2023; Serna-Zuluaga et al., 2024). So much so that, an approach to the study of entrepreneurship through the lens of neuroscience is at the centre of the current debate (Juarez-Varon et al., 2024; Liu et al., 2022a; Sharma et al., 2021a). Although still rare, studies have now begun applying neuroscience techniques, giving rise to the concept of *Neuro-entrepreneurship* (de Holan, 2014; Nicolaou & Shane, 2014; Sharma et al., 2021a; Tracey & Schluppeck, 2014). Neuroentrepreneurship is the result of intersection of neuroscience, viewing as the opportunity of a brain-driven approach for entrepreneurship (Butler et al., 2016; de Holan, 2014; Drover et al., 2017; Nicolaou et al., 2019). Its application can provide key insights into understanding entrepreneurship holistically (Bear et al., 2020). Recent contributions emphasise that different neuroscientific tools present complementary strengths—ranging from high temporal resolution in EEG to more naturalistic, behaviour-based measures supported by machine-learning approaches—and that their suitability depends on the specific research questions and context of the study (Nicolaou & Shane, 2014; Sharma et al., 2021b; Zuluaga et al., 2025). In this context, the application of an Emotion AI platform based on convolutional neural networks (CNNs) in the present research aligns with this methodological pluralism, offering a flexible, non-intrusive and anonymised option to capture substantial emotional data in an

educational setting. Fig. 1 illustrates the proposed model and the hypotheses developed in this study.

3. Methods

3.1. Data collection

Fieldwork was conducted in two different activities for training entrepreneurial competences—a successful case with an entrepreneur and an ideathon—during academic year 2022–2023 in a Spanish public university. A total of 117 students enrolled in different courses under the Faculty of Marketing and Management participated in the study (Table 1) (Fig. 2). The sample in both activities maintains statistically recommended levels of confidence (95%) and margin of error (5%). Although the sample is restricted to a single institution, its size is consistent with methodological recommendations for PLS-SEM, which indicate that the minimum required sample should be at least 10-times the maximum number of arrows pointing at any endogenous construct; this condition is met in our model. Moreover, smaller samples are commonly accepted in studies using neuroscience tools rather than only traditional survey-based designs owing to the complexity of data collection and the costs of implementation in the field (Baker et al., 2021). In this study, each participant was exposed to two entrepreneurship education activities and multiple repeated emotion measurements through the Emotion AI system, which enhances the precision of the estimated effects (Gocen, 2020; Juarez-Varon et al., 2024). Two instruments were applied: one belonging to the neuroscience field (the Emotion AI platform based on CNNs) and a questionnaire based on the TPB model to measure EI and perceived employability.

The neuroscience instrument utilised was CNNs connected with an AI platform. This technology detects the facial expressions and postures-related emotions on a monitored surface, and classifies and counts them, drawing conclusions about how they feel on that surface or what they do without having the image or any data that identifies the image, only aggregated counters. Thus, each emotional expression is registered. It is a technology patented by the company Goli Neuromarketing, reference in neuromarketing and neuroscience analysis in real environment. Moreover, the report clarifies that Emotion AI enables computers to analyse and ascertain human non-verbal signs to deduce the emotions expressed. The information is encrypted at all stages of the process. Thus, CNNs connected to the AI recognise and count emotional expressions but do not uniquely identify a person but rather the sum of emotions expressed. Consequently, it is an irreversible anonymisation process that only allows linking the summation of each emotion with an

Table 1
Sample composition by gender.

| | Act 1 | Act 2 | Total |
|--------|-------|-------|-------|
| Female | 36 | 26 | 62 |
| Male | 27 | 28 | 55 |

alphanumeric code that is uniquely associated with the gender of the individual to follow the trasability of the emotions during the entire measured activity. The measurement of emotions was conducted at two different time points to analyse the impact of the educational entrepreneurial programme (EEP): prior to starting and during the activities.

In recent years, neuroentrepreneurship research has relied on a wide range of neuroscientific tools, including neuroimaging techniques such as EEG, fMRI and fNIRS, as well as machine-learning approaches such as CNNs, all of which have documented advantages and have been successfully applied in social science and management research (Nicolaou et al., 2019; Sharma et al., 2021b). The choice among these tools largely depends on the specific context, research questions and characteristics of the target population; in our case, the flexibility of the Emotion AI platform—its ability to capture emotions in a naturalistic setting, in an anonymised manner and while generating substantial behavioural data—rendered it particularly suitable for this study.

Conversely, the questionnaire based on the TPB Model was completed by the participants before and immediately after the activities. The double measurement contributes to contrast the increase of two main dependent variables: employability and EI. As a result of the statistical changes, a PLS-SEM Model was worked with the obtained ratios through these two moments for variables related to the TPB model and for the emotions experienced.

To eliminate the possibility of non-response bias, we split the sample into two segments. The initial segment comprised 80% of the first responses, while the remaining responses constituted the second segment. Subsequent ANOVA revealed no notable distinctions between the established groups. To demonstrate minimal likelihood of a common method bias issue among latent variables, it was confirmed that the degree of explanation by a single factor within our research model was 31.54%. Harman’s single-factor analysis suggests that the preferred level at which a single factor accounts for observed variables via principal component should be below 50% (Podsakoff et al., 2003).

3.2. Variables

Ajzen’s TPB Model (1991) variables support the research design. As stated above: PA, SN, PBC like independent variables and EI and

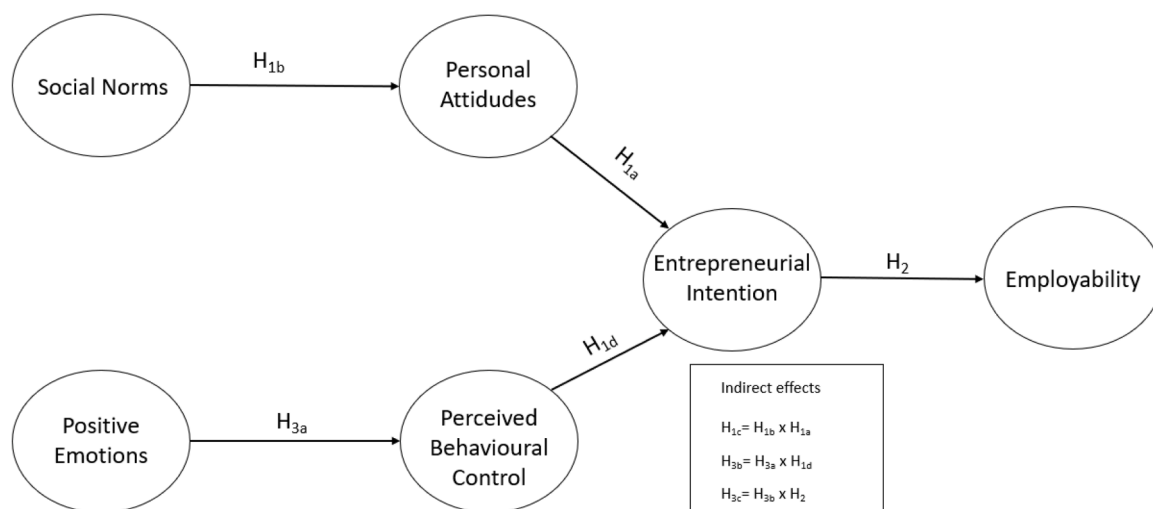


Fig. 1. Proposed model.

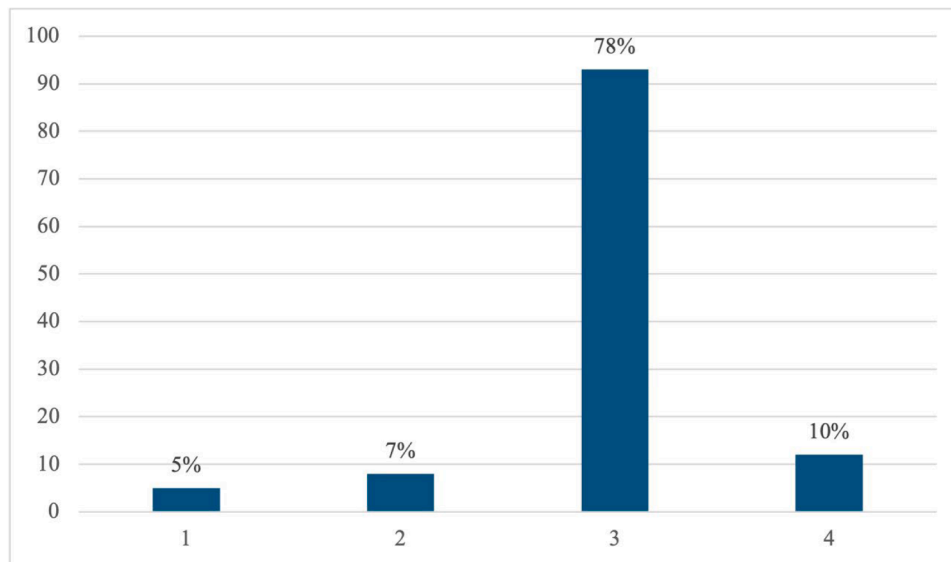


Fig. 2. Sample composition by course.

Employability, were directly dependent and related between each other. EI, PA, SN and PBC were measured using multi-item 7-point Likert scales adapted from Ajzen's (1991) TPB framework and from validated instruments for university students in entrepreneurship education (e.g. Liñán & Chen, 2009; Fayolle & Gailly, 2015). Items for PBC captured students' beliefs about their capability to start a business and to perform core entrepreneurial tasks. Following this approach, the effect of EI on Employability was modelled. All variables were measured on 7-point Likert scales.

Additionally, the emotions were included. Positive emotions were not assessed through the questionnaire but were derived from the Emotion AI system, which classified and counted facial expressions and postures associated with specific positive emotions (such as joy or interest) during the activities. These measures were aggregated to obtain individual positive emotion scores for each educational activity. Emotions were encoded by the IA platform based on the accumulation and counting of each one and their intensity with values between 0 and 200. This coding seeks the mathematical paralleling of the reference measurement scale to deduce emotions according to the metabolic activity of the brain cells in second intervals under its range, these values, ranging from 0 to 0.2 by sensor type. Consequently, data comparison becomes possible because of the numerical standardisation established for both groups of variables. It is noteworthy that in this study, emotions were measured immediately before and during the entrepreneurship education activities to capture short-term affective responses to the specific pedagogical experiences and to examine how these situational emotional states relate to PBC, EI and self-perceived employability at the end of the intervention.

3.3. Data analysis

The model was analysed using the PLS-SEM method. The primary rationale behind selecting this approach was the composition of the model, which comprises six composite types A (Cepeda Carrión et al., 2016). PLS-SEM is deemed more appropriate for hypothesis testing compared to other methods such as structural equation modelling (Hair et al., 2017). Several other factors also contributed to the choice of this method. PLS-SEM is well-suited for examining intricate relationships and mediating effects (Aledo-Ruiz et al., 2021). Additionally, it is advantageous as it does not necessitate a specific indicator distribution (Chin & Dibbern, 2010). The causal perspective from which the model was estimated was another consideration (Hair et al., 2020). To validate

the hypotheses, a bootstrapping procedure with 10,000 subsamples was conducted (Henseler, 2018a), using SmartPLS 4.2 (Ringle et al., 2015).

4. Results

To verify the proposed hypotheses, first, the measurement model will be analysed to confirm the validity and reliability of the items and variables applied. The reliability of the items applied is verified through the study of their loadings. The results presented in Table 2 show that the vast majority of the items exceed the minimum established value of 0.7, and those that do not are very close to this value, being in any case above 0.4—a threshold beyond which an item may be retained in the model if it is of interest (Hair et al., 2019). Likewise, the reliability of the construct was assessed by examining Cronbach's alpha, composite reliability and the Dijkstra-Henseler rho ratio. Given that these values surpass the threshold of 0.7, it can be inferred that the construct demonstrates satisfactory reliability (Dijkstra & Henseler, 2015). Finally, the average variance extracted (AVE) was utilised to assess convergent validity. It is notable that all values exceed 0.5, thus confirming the internal consistency of the constructs (Hair et al., 2020).

In addition to the relevant model checks, correlations between EI and employability were analysed. It is worth highlighting the results that relate the correlation to the course of study of the sample. The students' year of study showed only weak correlations with EI (approximately between -0.10 and -0.30 across the different datasets) and with perceived employability (ranging from approximately -0.15 to $+0.25$), which is consistent with the strong concentration of participants in the third year—precisely the moment when reflection about future career paths becomes most salient.

Discriminant validity was also assessed (results presented in Table 3). First, Fornell-Larcker's criterion (Fornell & Larcker, 1981) was applied, ensuring that the correlations between each pair of constructs are below the square root of the AVE (Henseler, 2018b). Additionally, it was confirmed that the HTMT values do not surpass the predefined maximum of 0.85 (Hair et al., 2019).

Another test was conducted to ascertain that the standardized square root residual (SRMR) did not exceed the maximum value of 0.08 (Henseler et al., 2016). This demonstrates the good fit of the model. Subsequently, prior to analysing the structural model, the Variance Inflation Index (VIF) was assessed to identify potential multicollinearity issues. As shown in Table 4, the VIF values range from 1.000 to 1.396, indicating the absence of multicollinearity problems within this model

Table 2
Measurement model analysis.

| Composite indicators | Mean | SD | Loading | t-student* | α | ρ_A | ρ_C | AVE |
|--------------------------------------|--------|--------|---------|------------|----------|----------|----------|-------|
| Social Norms | | | | | 0.821 | 0.902 | 0.875 | 0.639 |
| SN_1 | 6.080 | 1.249 | 0.847 | 21.223 | | | | |
| SN_2 | 6.231 | 1.042 | 0.782 | 11.201 | | | | |
| SN_3 | 5.798 | 1.196 | 0.678 | 7.256 | | | | |
| SN_4 | 5.958 | 1.122 | 0.878 | 26.988 | | | | |
| Personal Attitudes | | | | | 0.821 | 0.893 | 0.876 | 0.567 |
| PA_1 | 5.273 | 1.239 | 0.581 | 8.682 | | | | |
| PA_2 | 5.529 | 1.337 | 0.797 | 21.407 | | | | |
| PA_3 | 5.748 | 1.401 | 0.894 | 57.008 | | | | |
| PA_4 | 5.574 | 1.316 | 0.886 | 52.064 | | | | |
| PA_5 | 5.227 | 1.483 | 0.883 | 43.393 | | | | |
| PA_6 | 4.395 | 1.578 | 0.849 | 3.009 | | | | |
| Perceived Behavioural Control | | | | | 0.914 | 0.914 | 0.933 | 0.701 |
| PBC_1 | 4.357 | 1.424 | 0.764 | 29.170 | | | | |
| PBC_2 | 3.651 | 1.614 | 0.847 | 34.066 | | | | |
| PBC_3 | 3.597 | 1.579 | 0.893 | 52.622 | | | | |
| PBC_4 | 3.685 | 1.584 | 0.867 | 45.962 | | | | |
| PBC_5 | 3.706 | 1.629 | 0.867 | 44.772 | | | | |
| PBC_6 | 4.197 | 1.574 | 0.778 | 23.954 | | | | |
| Entrepreneurial Intention | | | | | 0.961 | 0.963 | 0.969 | 0.838 |
| EI_1 | 4.139 | 1.671 | 0.794 | 26.373 | | | | |
| EI_2 | 4.941 | 1.623 | 0.926 | 71.413 | | | | |
| EI_3 | 4.962 | 1.669 | 0.926 | 84.946 | | | | |
| EI_4 | 4.806 | 1.697 | 0.953 | 144.124 | | | | |
| EI_5 | 4.667 | 1.728 | 0.947 | 122.807 | | | | |
| EI_6 | 5.030 | 1.689 | 0.938 | 104.649 | | | | |
| Positive Emotions | | | | | 0.773 | 0.838 | 0.837 | 0.514 |
| PE_1 | 9.319 | 11.418 | 0.797 | 6.226 | | | | |
| PE_2 | 38.458 | 49.607 | 0.828 | 6.598 | | | | |
| PE_3 | 31.424 | 39.620 | 0.758 | 5.692 | | | | |
| PE_4 | 27.601 | 22.567 | 0.603 | 2.714 | | | | |
| PE_5 | 23.097 | 27.414 | 0.647 | 4.488 | | | | |
| Employability | | | | | 0.852 | 0.927 | 0.885 | 0.608 |
| EMP_1 | 5.764 | 1.035 | 0.816 | 31.942 | | | | |
| EMP_2 | 5.658 | 1.256 | 0.857 | 48.290 | | | | |
| EMP_3 | 6.072 | 1.008 | 0.820 | 21.307 | | | | |
| EMP_4 | 6.139 | 0.988 | 0.736 | 12.920 | | | | |
| EMP_5 | 6.221 | 0.949 | 0.653 | 10.658 | | | | |

Significance and standard deviations (SD) performed by 10,000 repetitions Bootstrapping procedure. α : Chronbach’s alpha; ρ_A : Dijkstra–Henseler’s composite reliability; ρ_C : Jöreskog’s composite reliability; AVE: Average Variance Extracted; *: All loadings are significant at the 0.001 level.

Table 3
Discriminant validity analysis.

| | | I | II | III | IV | V | VI |
|------------|--------------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|
| I | Employability | <i>0.780</i> | 0.457 | 0.243 | 0.629 | 0.142 | 0.484 |
| II | Entrepreneurial Intention | 0.481 | <i>0.916</i> | 0.692 | 0.812 | 0.151 | 0.153 |
| III | Perceived Behavioural Control | 0.273 | 0.649 | <i>0.837</i> | 0.623 | 0.180 | 0.129 |
| IV | Personal Attitudes | 0.574 | 0.730 | 0.533 | <i>0.753</i> | 0.183 | 0.325 |
| V | Positive Emotions | 0.098 | 0.131 | 0.176 | 0.101 | <i>0.717</i> | 0.099 |
| VI | Social Norms | 0.384 | 0.152 | -0.040 | 0.288 | 0.027 | <i>0.800</i> |

HTMT ratio over the diagonal (bold). Fornell–Lacker criterion: square root of AVE in diagonal (italics) and construct correlations below the diagonal.

Table 4
VIF analysis.

| | | I | II | III | IV | V | VI |
|------------|--------------------------------------|---|-------|-------|-------|-------|-------|
| I | Employability | | 1.000 | | | | |
| II | Entrepreneurial Intention | | | 1.396 | 1.396 | | |
| III | Perceived Behavioural Control | | | | | 1.000 | |
| IV | Personal Attitudes | | | | | | 1.000 |
| V | Positive Emotions | | | | | | |
| VI | Social Norms | | | | | | |

(Kock, 2015).

Next, to confirm or refute the hypotheses, the signs, magnitudes and statistical significance of the paths comprising the established

relationships were analysed. The results are displayed in Table 5 and Fig. 3. For this purpose, a one-tailed percentile bootstrapping test with 10,000 subsamples and a significance level of 5% was applied.

The results shown in Table 5 and Fig. 3 demonstrate how all the hypotheses proposed in this research are supported. The analysis of direct effects shows that the effect of PA on EI is positive and significant ($\beta=0.677^{***}$), thus supporting H_{1a}. Similarly, SN positively and significantly affect PA ($\beta=0.288^{***}$), thereby validating H_{1b}. PBC positively and significantly influences EI ($\beta=0.289^{***}$), supporting H_{1d}. EI positively and significantly affects Employability ($\beta=0.448^{***}$), validating H₂. Finally, the results also demonstrate how positive emotions positively and significantly influence PBC ($\beta=0.176^{**}$); so, H_{3a} is also supported.

Regarding the indirect effects, the results demonstrate how SN positively and significantly influence EI but do so through PA ($\beta=0.195^{**}$), thus validating H_{1c}. Similarly, EI is positively and

Table 5
Structural model assessment.

| | Path | SD | T-value | f ² | CI: 5% | CI: 95% | H | Supported |
|--|-------|-------|-----------|----------------|--------|---------|-----|-----------|
| Direct effects | | | | | | | | |
| Personal Attitudes -> Entrepreneurial Intention | 0.677 | 0.036 | 18.578*** | 1.308 | 0.616 | 0.735 | H1a | YES |
| Social Norms -> Personal Attitudes | 0.288 | 0.057 | 5.005*** | 0.090 | 0.203 | 0.393 | H1b | YES |
| Perceived Behavioural Control -> Entrepreneurial Intention | 0.289 | 0.044 | 6.544*** | 0.238 | 0.215 | 0.362 | H1d | YES |
| Entrepreneurial Intention -> Employability | 0.481 | 0.045 | 10.600*** | 0.301 | 0.410 | 0.559 | H2 | YES |
| Positive Emotions -> Perceived Behavioural Control | 0.176 | 0.063 | 2.809** | 0.032 | 0.120 | 0.293 | H3a | YES |
| Indirect effects | | | | | | | | |
| <i>Individual indirect effects</i> | | | | | | | | |
| Social Norms -> Personal Attitudes -> Entrepreneurial Intention | 0.195 | 0.040 | 4.817** | | 0.136 | 0.270 | H1c | YES |
| Positive Emotions -> Perceived Behavioural Control -> Entrepreneurial Intention | 0.051 | 0.021 | 2.463** | | 0.032 | 0.092 | H3b | YES |
| Positive Emotions -> Perceived Behavioural Control -> Entrepreneurial Intention -> Employability | 0.024 | 0.010 | 2.349** | | 0.015 | 0.046 | H3c | YES |

R² adjusted [95% CI in brackets]: Personal Attitudes: 0.079 [0.037; 0.150]; Perceived Behavioural Control: 0.027 [0.011; 0.082]; Entrepreneurial Intention: 0.747 [0.693; 0.802]; Employability: 0.228 [0.165; 0.310]. SD: Standard Deviation; f²: size effect index; CI: 95% Bias Corrected Confidence Interval; Significance, standard deviations, 95% bias-corrected CIs were performed by 10,000 repetitions Bootstrapping procedure.

** : p < 0.01.
***: p < 0.001.

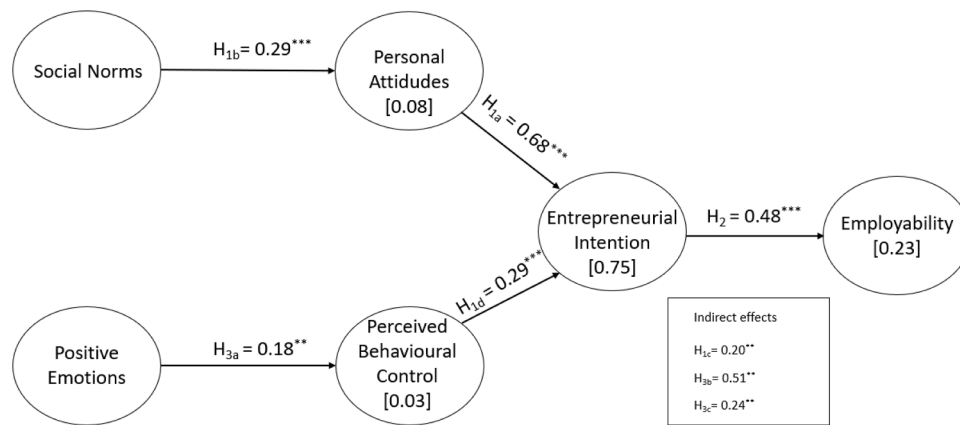


Fig. 3. Results for standardised path coefficients and R² values.

significantly influenced by positive emotions, but in this case, it occurs through PBC ($\beta=0.051^{**}$), supporting H_{3b}. Finally, based on the previous hypothesis, the results show how positive emotions positively and significantly influence Employability through PBC and EI sequentially ($\beta=0.024^{**}$). Thus, H_{3c} is supported. All direct and indirect paths specified in the model are statistically significant ($p < 0.01$ or $p < 0.001$), indicating robust relationships between the TPB constructs, positive emotions and employability.

The analysis of R² indicates that this model accounted for 27% of the variance in PBC, 79% in PA, 75% in EI and 23% in Employability. According to Hair et al. (2019), values of 0.75, 0.50 and 0.25 are deemed substantial, moderate and weak, respectively. Hence, these findings affirm the model’s satisfactory explanatory capacity of the model. These R² values, together with the observed f² effect sizes, suggest that the model has substantial explanatory power for EI and non-trivial explanatory power for employability, while also capturing meaningful variance in PBC and PA. To further assess the practical significance of these relationships, the effect size (f²) was examined.

To summarise the evaluation of the structural model, the effect size (f²) was examined. This metric quantifies the impact of each independent variable on the dependent variable it affects. According to Cohen (1988), the findings indicate that SN have a weak effect on PA. The same applies to the relationship between positive emotions and PBC. The effect is moderate in the relationship between EI and Employability, as well as in the relationship between PBC and EI. Finally, a significant effect of PA on EI was observed.

5. Discussion

5.1. Discussion of results

The discussion section is structured to interpret the empirical results in the context of the theoretical framework and to address both the research questions and the proposed hypotheses. First, the findings are examined in relation to the TPB and prior work on entrepreneurship education, highlighting how they confirm or add nuance to the hypothesised relationships. Second, the discussion explicitly answers the three research questions by integrating the effects of positive emotions, PBC, EI and employability, thereby clarifying the theoretical and practical implications of the study.

The positive effects of competence-based training and entrepreneurial education programme on EI, and even on employability, observed in this research are consistent with previous findings in the field (Ayala Calvo & Manzano García, 2021; Fayolle & Gailly, 2015; Iglesias-Sánchez et al., 2016; Laguna-Sánchez et al., 2020; Magd & Kunjumammed, 2024; Nguyen & Nguyen, 2023; O’Leary, 2017; Shane, 2000; Uddin et al., 2022). Particularly, the significant relationships between PA and EI and between PBC and EI confirm the central role of these TPB antecedents in explaining students’ EI and enable validating H1.a and H1.d. Likewise, the proposal model links the positive effect of SN on PA, nor both directly on EI as usually. This variation of the original TPB model has been previously explored (Aloulou, 2016; Engle et al., 2010; López-Delgado et al., 2019) and, in this study, also shows the strength of the effect with this logic. Consequently, H1.b is

contrasted.

However, the effect of EI in perceived employability is a new insight. Very few studies have explored EI and employability jointly (Ayala Calvo & Manzano García, 2021; Pardo-García & Barac, 2020; Perrin Moore et al., 2011; Santos-Jaén et al., 2022; Vargas et al., 2018). Consequently, this insight is among the most outstanding contributions, according to H2. This statement corroborates all the reflections about the value of training competences on employability (Fayolle & Gailly, 2008; Linan, 2008; Pardo-García & Barac, 2020; Perez-Macias et al., 2023; Taneja et al., 2024) but, in this case, with evidence that entrepreneurship-related skills not only increase the willingness to undertake entrepreneurship in the future, but also the perception of having more opportunities to obtain a qualified job in line with their degree. In other words, the results extend TPB-based research by showing that EI operates as a bridge between educational interventions and students' employability perceptions.

Additionally, the introduction of emotions with the general previous assumptions related TPB Model should be emphasised. The effects of emotions on entrepreneurial processes remain an open discussion (Bonesso et al., 2018; Lackéus, 2014a; Naqvi et al., 2006; Serna-Zuluaga et al., 2024; Ukil et al., 2025), even focusing specifically on entrepreneurial education (Liu et al., 2022b; Shane, 2000). To elucidate the complex phenomenon of entrepreneurship, new approaches, including methodological ones such as neuroscience, are required; however, research in this direction remains insufficient. The lens of emotions employed in this study provides a better understanding of knowledge, intentional behaviour and projecting themselves in future. This supposes a step forward in research and evidence: (1) the stronger relationship between cognition, affection and behaviour and (2) moreover the importance of emotion management (Bagozzi et al., 2003; Foo, 2011; Welpé et al., 2012). In this regard, it is noteworthy that these results coincide with previous contributions (Lackéus, 2014b; Welpé et al., 2012), but they introduce an innovative element by combining traditional instruments (TPB-based questionnaires) with neuroscience tools (CNNs) to capture students' emotional responses. Thus, H3a, H3b and H3c can be supported. This finding is especially significant for its practical implication. It places at the centre of the debate the significance of emotional level in decision making and the construction of people's present and future images.

The results enable answering the research questions. Regarding the first research question, the results show that positive emotions elicited during entrepreneurial education programme have a significant positive effect on PBC, and through this construct they also contribute to increasing EI among students. Regarding the second question, the findings confirm that EI is positively related to self-perceived employability, supporting the idea that intention functions as a key mediator between entrepreneurship education and graduates' employability perceptions. Finally, regarding the third question, the application of the Emotion AI platform based on CNNs provides additional insights into the relationships among emotions, PBC, EI and employability, thereby evidencing the value of neuroscientific tools for advancing the theory in entrepreneurship education.

5.2. Theoretical contributions

First, it advances TPB-based research by explicitly integrating employability as an outcome of EI in the context of entrepreneurship education. While prior works have suggested that entrepreneurial competences and intention may be linked to graduates' employability (Kolvereid, 1996; Machin & McNally, 2007; Magd & Kunjumammed, 2024; Nguyen & Nguyen, 2023; Pardo-García & Barac, 2020; Santos-Jaén et al., 2022), empirical studies jointly modelling TPB constructs, EI and employability remain scarce. By showing that EI is positively associated with self-perceived employability after competence-based interventions, the study reinforces the view of TPB as a useful framework not only for explaining venture creation, but also for

understanding broader career-related outcomes in higher education.

Second, the study contributes to the growing literature on emotions and entrepreneurship by integrating positive affects into a TPB model of EI. Prior research has underlined the role of emotions in opportunity evaluation, risk perception and entrepreneurial motivation (Foo, 2011; Grégoire et al., 2015; Hayton & Cholakova, 2012; Pan et al., 2025; Serna-Zuluaga et al., 2024; Vesci et al., 2024), but relatively few studies have formally incorporated affective states as antecedents of TPB constructs in educational settings. The finding that positive emotions enhance PBC, which in turn promotes EI and indirectly influences employability, offers empirical support for theoretical proposals that call for combining cognitive and affective processes in models of entrepreneurial decision-making (Bagozzi et al., 2003; Lackéus, 2014a; Massaro et al., 2023).

Third, the research contributes to the emerging field of neuro-entrepreneurship by illustrating how neuroscientific tools can be applied to study entrepreneurship education. Previous conceptual and empirical explorations have posited that neuroimaging and neurophysiological methods can enhance the understanding of entrepreneurial cognition and affect (de Holan, 2014; Juarez-Varon et al., 2024; Nicolau et al., 2019; Sharma et al., 2021b), but applications in educational contexts remains scarce. By employing an Emotion AI platform based on CNNs alongside a TPB-based survey and PLS-SEM, this study exemplifies a methodological approach that aligns with calls for multi-method, brain-informed research on entrepreneurship and demonstrates the feasibility of capturing affective dynamics in naturalistic learning environments.

5.3. Limitations and future research directions

The innovations presented in this work should be interpreted in light of several limitations that open avenues for future research. First, the study is restricted to a single Spanish university and to marketing and business students, which limits the generalisability of the findings to other institutional and disciplinary contexts. Replicating the study in other countries and with students from different subject areas and degree programmes would enable testing the robustness of the proposed relationships and the role of emotions in more heterogeneous populations.

Second, the design is cross-sectional at the level of each educational activity, capturing emotions and intentions only before and immediately after the interventions. This temporal scope prevents examining how the effects of positive emotions on PBC, EI and employability evolve over time. Additionally, given that participants were undergraduate students who had not yet entered the labour market, employability was conceptualised as a self-perceived construct rather than as objective employment outcomes. Future longitudinal research could address both these limitations by including follow-up measurements of emotions, intentions and perceptions several months after the training and by tracking graduates' actual employment trajectories, to assess the durability and real-world consequences of the observed effects. Other relevant point to highlight is that the analysis is, therefore, primarily explanatory, and future research could complement it with explicit out-of-sample predictive assessments. Finally, the study relies on a specific neuroscientific tool for measuring emotions; comparative studies using alternative methods could help assess the convergent validity of emotion measures and refine the choice of tools for different entrepreneurship education settings.

5.4. Practical implications

The study has implications for entrepreneurship education because the connections between the design of EEP and the emotions that evoke EI and Employability are potentiated. A rigorous plan for entrepreneurship education should therefore be developed. Higher education institutions should establish programmes with meaningful and

motivating activities that arouse positive emotions because, to a large extent, the impact beyond their knowledge depends on it.

The challenge of neuroscience implementation in the field of entrepreneurship studies is emphasised as a practical implication. Especially in this case, it is applied to better test the efficacy of programmes for improving employability and enhancing the entrepreneurial vocation for university graduates. In practical terms, these results suggest that policymakers and programme designers should deliberately incorporate emotionally engaging activities and, where feasible, complementary neuroscientific tools into entrepreneurship education to monitor students' affective responses and more accurately evaluate the impact of different pedagogical designs on both EI and employability.

6. Conclusion

This study shows that positive emotions experienced during entrepreneurial education programme enhance students' PBC and EI, thereby reinforcing their self-perceived employability. The evidence obtained confirms that EI acts as a bridge between competence-based training and employability, underlining the central role of self-efficacy in shaping students' career-related perceptions.

By integrating Emotion AI data with a TPB-based model estimated through PLS-SEM, the study also demonstrates the added value of combining neuroscientific tools with traditional self-report measures in entrepreneurship education research. Collectively, these findings support the design of innovative, emotionally engaging entrepreneurship activities as a practical way for universities to foster both entrepreneurial careers and broader employability outcomes. Definitely, this research provides a new approach to the study of entrepreneurship by incorporating neuroscientific tools that complement classic instruments and offer a more holistic view of entrepreneurial activity and the cognitive and social factors involved.

CRedit authorship contribution statement

Patricia P. Iglesias-Sánchez: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **José Manuel Santos-Jaén:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Carmen Jambrino-Maldonado:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Carlos de las Heras-Pedrosa:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

None.

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