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Empowering Digital Entrepreneurship Intention: Unveiling the Role of Education

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Abstract

Entrepreneurs' digital entrepreneurial capabilities can enhance the interaction between digital innovation and digital entrepreneurship. This study explores the influence of digital entrepreneurial capabilities (digital entrepreneurial education, alertness, and knowledge) on the digital innovative attitude and entrepreneurial intention of higher education students. A sample of 417 Portuguese higher education students was collected, and the partial least squares method was applied to the research model. The results showed that higher education students' innovative digital attitudes and digital entrepreneurial intentions are positively influenced by their digital entrepreneurial alertness and knowledge. Digital entrepreneurial education was not significant in affecting innovative digital attitudes. However, when an innovative digital attitude acts as a mediator, the relationship between digital entrepreneurial intentions and digital entrepreneurial capabilities is stronger. Thus, the importance of digital entrepreneurial education, alertness, and knowledge as precursors to the intention of digital entrepreneurship is emphasized, as well as the importance of these capabilities in promoting digital innovation. The main contribution of this study is to demonstrate the mediating role of the digital innovative attitude in the association between digital entrepreneurial capabilities and digital entrepreneurial intention. These effects intensify the associations between digital entrepreneurial alertness and digital entrepreneurial knowledge with digital entrepreneurial intention, shedding light on how digital entrepreneurship capabilities shape students' innovative digital attitudes and entrepreneurial intentions and enable articulate digital innovation with digital entrepreneurship.

Keywords Digital entrepreneurial capabilities · Digital entrepreneurship education · Digital entrepreneurial alertness · Digital entrepreneurial knowledge · Innovative digital attitude

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Introduction

The rise of digital entrepreneurship has profound implications for the modern economy, reshaping traditional business models and opening up new avenues for growth and development (Antonizzi & Smuts, 2020; Gomes & Lopes, 2023). By harnessing the power of digital technologies, entrepreneurs can reach global markets, streamline operations, and expand their companies more efficiently (Li, 2024; Shen et al., 2018). This shift toward digital entrepreneurship is essential for stimulating economic growth, creating job opportunities, and promoting innovation (Antonizzi & Smuts, 2020). As Nambisan (2017) suggests, the intersection between digital technologies and entrepreneurship presents a wealth of new possibilities for ambitious individuals looking to create successful businesses in the digital age. The adoption of digital entrepreneurship not only fuels individual success but also contributes to the overall dynamism and competitiveness of the economy in general (Antonizzi & Smuts, 2020; Kollmann et al., 2022).

Digital entrepreneurship involves pursuing commercial or economic opportunities using digital technologies (Anim-Yeboah et al., 2020; Lungu et al., 2024). This concept encompasses the creation of new companies within the digital economy, where entrepreneurs take advantage of the Internet and innovative digital tools to create and develop their companies (Kraus et al., 2019; Shen et al., 2018). Digital entrepreneurship is the act of founding new companies in the digital economy, highlighting the close relationship between entrepreneurship and digital technologies (Paul et al., 2023). This definition underlines the essential role of digital tools and platforms in shaping the contemporary entrepreneurship landscape, providing a framework for understanding the evolving nature of business creation and innovation in the digital age. Digital entrepreneurs have a unique set of characteristics that differentiate them from traditional entrepreneurs (Antonizzi & Smuts, 2020). These individuals combine elements of business acumen, institutional knowledge, and technological skills to drive innovation and create value in the digital domain (Ndou et al., 2019; Steininger et al., 2022). The adaptability of digital entrepreneurs is a crucial characteristic that allows them to navigate a dynamic and fast-paced digital environment, responding to technological advances, market trends, and consumer preferences (Honig & Samuelsson, 2021; Srinivasan & Venkatraman, 2018).

The digital entrepreneurship landscape in Portugal has seen a notable increase in the number of digital startups in recent years (ITA, 2024). According to the Startup Portugal report for 2023, the number of startups in Portugal has been growing in recent years, with a current total of 4,073 startups, which combined generate a turnover of 2.3 billion euros and exports valued at 1.3 billion euros. These companies account for approximately 25,000 jobs in the country (Startup Portugal, 2023). These figures demonstrate a growing interest and investment in digital entrepreneurship. This growth is further supported by the fact that 84% of startups in Portugal are high-tech startups, indicating a strong focus on innovation and technology-oriented ventures (Startup Portugal, 2023).

Entrepreneurs in Portugal often rely on the support of incubators during the early stages of their projects, which highlights the importance of incubation programs in promoting digital start-ups (ITA, 2024). The entrepreneurial ecosystem in Portugal is

mainly made up of technology-based companies (40%), fintech (22%), health (15%), B2B (12%), and others: 11% (Portugal Digital, 2023). Despite the growth and support for digital entrepreneurship in Portugal, the country's entrepreneurs face certain challenges that can affect their ventures (European Commission, 2023). One of the main challenges lies in increasing the population's digital skills levels, as highlighted by the Digital Economy and Society Index (DESI) (European Commission, 2023). In 2023, only 56% of the Portuguese population aged between 16 and 74 had digital skills at a basic level or above (INE, 2023). In Portugal, the density of STEM (Science, Technology, Engineering, and Mathematics) graduates and engineering professionals is remarkably high. Portugal stands out with the third-highest engineering graduation rate in the European Union, with approximately 90,000 new graduates each year (ITA, 2024). Digital entrepreneurial capabilities are fundamental to its development.

In today's digital economy, the success of business ventures is intrinsically linked to the acquisition and application of specialized skills adapted to the digital landscape. This symbiotic relationship between digital entrepreneurship and digital entrepreneurial capabilities is multifaceted, spanning the domains of Digital Entrepreneurship Education, Digital Entrepreneurial Alertness, and Digital Entrepreneurial Knowledge. The synergy between Digital Entrepreneurial Education, Digital Entrepreneurial Alertness, and Digital Entrepreneurial Knowledge is key to fostering successful digital entrepreneurship ventures. Digital Entrepreneurial Education lays the foundation by providing individuals with the knowledge and skills needed to navigate the digital realm. At the same time, Digital Entrepreneurial Alertness enhances its ability to spot opportunities and adapt to market dynamics (Wibowo et al., 2023). In addition, Digital Entrepreneurial Knowledge serves as a bridge between education and action, empowering entrepreneurs to effectively apply their knowledge in business ventures (Darmanto et al., 2023). Research exploring the association between digital entrepreneurship skills and entrepreneurial intentions highlights the transformative impact of Digital Entrepreneurial Education, Digital Entrepreneurial Alertness and Digital Entrepreneurial Knowledge in shaping individuals' attitudes, behaviors and outcomes in the field of digital entrepreneurship (Abaddi, 2023; Mir et al., 2023; Wibowo et al., 2023). By integrating these elements cohesively, aspiring entrepreneurs can improve their entrepreneurial skills, drive innovation, and achieve sustainable success in the digital economy.

One of the significant gaps in the literature on Digital Entrepreneurship Education is the limited research on the effectiveness of Digital entrepreneurship education programs (Sitaridis & Kitsios, 2024). While there is growing interest in integrating digital entrepreneurship into educational curricula, there is a lack of comprehensive studies that assess the impact of these programs on students' entrepreneurial skills and outcomes. Research exploring how knowledge of digital entrepreneurship influences students' entrepreneurial intentions and the development of soft skills is particularly scarce (Wibowo et al., 2023; Zainal & Yong, 2020). What is the influence of Digital Entrepreneurship Education on the innovative digital attitude and digital entrepreneurship intention of higher education students?

In the field of Digital Entrepreneurial Alertness, there is a notable gap in studies investigating the relationship between digital entrepreneurial alertness and business

success (Purwandari & Sadik, 2024). Entrepreneurial alertness, defined as the ability to identify and act on entrepreneurial opportunities, plays a key role in the entrepreneurial process (Sharma, 2019). However, research conducted to examine how digital entrepreneurial alertness specifically affects the performance and outcomes of digital entrepreneurship is yet to be explored in different contexts (Wibowo et al., 2023). By examining this relationship, researchers can provide valuable insights into the factors that contribute to digital entrepreneurship success and inform strategies to improve digital business creation. What is the influence of Digital Entrepreneurial Alertness on higher education students' innovative digital attitude and digital entrepreneurship intention?

Another crucial gap in the literature concerns Digital Entrepreneurial Knowledge and the need for more research into its acquisition and application in digital entrepreneurship (Zhao, 2021). Although the importance of entrepreneurial knowledge in promoting entrepreneurial intentions and alertness is recognized (Purwandari & Sadik, 2024), there is a lack of comprehensive studies that delve into the specific acquisition processes and practical applications of digital business knowledge. Investigating how knowledge sharing in traditional education translates into digital entrepreneurship success can shed light on the mechanisms through which Digital Entrepreneurial Knowledge influences entrepreneurial outcomes and guides the development of effective knowledge dissemination strategies in digital entrepreneurship contexts (Sahut et al., 2021; Zhao, 2021). What is the influence of Digital Entrepreneurial Knowledge on the innovative digital attitude and digital entrepreneurship intention of higher education students?

This study aims to explore the influence of digital entrepreneurial capabilities on the innovative digital attitude and digital entrepreneurial intention of higher education students in Portugal. To this end, 417 higher education students in Portugal were surveyed.

This study makes four important contributions. Firstly, it advances the development of the literature on digital entrepreneurial capabilities by focusing on three critical aspects: Digital Entrepreneurship Education, Digital Entrepreneurial Alertness, and Digital Entrepreneurial Knowledge, which collectively enhance understanding of how digital capabilities drive entrepreneurial intentions. Secondly, our study reveals the critical role of mediating effects of innovative digital attitudes in establishing the significance of the relationship between Digital Entrepreneurial Capabilities and Digital Entrepreneurial Intention. These mediating effects highlight how Digital Entrepreneurial Alertness and Knowledge strengthen the link between education and intention, offering new insights into the mechanisms that shape entrepreneurial mindsets in the digital context. Fourthly, our study reaffirms the prominence of digital entrepreneurship within the broader entrepreneurial landscape. By emphasizing its transformative role and showcasing how digital technologies fuel business innovation, we stress the practical need for integrating Digital Entrepreneurship Education into curricula to prepare students with future-ready skills and a robust entrepreneurial mindset.

Theoretical Framework

Theory of Planned Behavior in Digital Entrepreneurship Education

The Theory of Planned Behavior (TPB) was formulated during the 1980th and was based on the early Theory of Reasoned Action. The TPB aims to predict and explain human behaviour within a context where individuals have incomplete volitional control over their actions (Ajzen, 1985; Gomes et al., 2024). This theory departs from three key determinants: attitudes toward the behaviour, subjective norms, and perceived behavioural control, and posits that the stronger the intention to engage in a behaviour, the more likely it will be performed, provided that the behaviour is under a person's volitional control (Lopes et al., 2024). The inclusion of perceived behavioural control into a model enables the TPB to handle situations where complete control over the behaviour is not possible, acknowledging that other non-motivational factors can influence the ability to perform the behaviour (Lopes et al., 2023b).

The TPB is highly effective in predicting and explaining behaviour, particularly when incorporating the construct of perceived behavioural control (Armitage & Conner, 2001), which enhances the prediction of behaviour, especially in situations where individuals perceive that they have control over their actions (Madden et al., 1992). However, the effectiveness of TPB varies with factors such as the operationalization of control and familiarity of behaviours, influencing the strength of perceived behavioural control's prediction on behaviour (Lopes et al., 2023a; Notani, 1998).

The adoption to the TPB in research science has been frequent, within a wide range of research fields. From health sciences, effectively predicting treatment adherence and adherence behaviour (Rich et al., 2015), health psychology, predicting behaviours like exercising, smoking cessation, and adherence to medical devices (Godin & Kok, 1996), and physical activity and diet behaviours (McEachan et al., 2011), to environmental science, including waste management, green consumption, climate and environment, saving and conservation, and sustainable transportation (Si et al., 2019), tourist's intention (Fauzi et al., 2024; Zheng et al., 2024), circular economy in construction projects (Adabre et al., 2023), farmers' adoption behaviour for disaster risk reduction (Mutyebere et al., 2023), pro-environmental behaviour (Leeuw et al., 2015), consumer behaviour (Khan et al., 2023), including green consumer's behaviour (Gordon-Wilson & Modi, 2015), and green buying behaviour (Khare, 2015). It has also been used to explain pro-environmental behaviour, examining people's intentions to act, influenced by their attitudes, subjective norms, and perceived control, and in predicting consumer behaviour and purchasing decisions, to understand how attitudes, subjective norms, and perceived behavioural control influence on buying behaviours (Yadav & Pathak, 2016).

The use of the TPB within the scope of education research is common, addressing a wide range of themes such as parents beliefs towards education services (Goh, 2009), predicting teacher's intentions to teach health education (Burak, 2002), teachers intentions towards inclusive education (Opoku et al., 2021), and teachers intentions to use technology in teaching (Teo et al., 2016).

Similarly, the TPB has been widely applied to study entrepreneurial behaviour, offering a framework to understand and predict entrepreneurial intentions and actions.

It highlights the role of intentions, as determined by attitudes, reflect individual beliefs and perceptions about entrepreneurship (Kautonen et al., 2013, 2015; Krueger & Carsrud, 1993). The TPB is particularly relevant in the context of entrepreneurship education, to address the effect of entrepreneurship programs on the entrepreneurial attitudes and entrepreneurial intention (Heuer & Kolvereid, 2014; Souitaris et al., 2007), and in digital entrepreneurship education (Al-Mamary & Alraja, 2022; Alferaih, 2022; Li et al., 2024; Nguyen & Nguyen, 2024). However, most studies using TPB in this context have emerged more recently.

TPB is commonly used to understand and predict entrepreneurial intentions and behaviours, analysing attitudes towards the behaviour, subjective norms, and perceived behavioural control. These components are particularly relevant for assessing the intentions of both students and educators in digital entrepreneurship, as supported by findings in entrepreneurship research (Kautonen et al., 2013), entrepreneurship education (Heuer & Kolvereid, 2014), and digital entrepreneurship education (Yaghoubi Farani et al., 2017). Furthermore, the TPB assumes that the best prediction of behaviour is given by asking people if they intend to behave in a certain way. Consequently, the core of the TPB theory resides into a more logical argument, as people are more likely to perform the behaviours that they feel positive toward and intend to perform. Yet, despite the widespread use of TPB across various research fields, the theory of planned behaviour should be modified to incorporate reciprocal causal relations, as intentions can influence attitudes, subjective norms, and perceived control over behaviour (Sussman & Gifford, 2019).

This study employs the TPB to assess how students' attitudes, subjective norms, and perceived behavioural control influence their intentions towards digital entrepreneurship. The analysis focuses on students' perceptions of the benefits and feasibility of engaging in digital ventures, considering elements such as digital entrepreneurial knowledge, digital entrepreneurial alertness, innovative digital attitude, and the perceived value of digital entrepreneurship education. These factors are expected to have a direct impact on students' intentions to pursue digital entrepreneurship. Subjective norms and perceived behavioural control are considered through the broader lens of students' social and environmental contexts and their self-assessed capabilities to perform entrepreneurial activities, respectively.

The TPB is a widely recognized framework for understanding entrepreneurial intentions, including digital entrepreneurship. It provides a comprehensive approach, including psychological factors such as attitudes towards behaviour, subjective norms and perceived behavioural control that influence entrepreneurial intentions and are critical in understanding the motivations behind digital entrepreneurship (Çela et al., 2025; Nguyen & Nguyen, 2024; Yaghoubi Farani et al., 2017). Moreover, TPB has been shown to predict entrepreneurial intentions, which are indicators of actual entrepreneurial behaviour and essential in the context of digital entrepreneurship, where intentions often precede actions (Al Halbusi et al., 2023). This approach can also be extended and integrated with other models and has been validated in the context of digital entrepreneurship, demonstrating its robustness and applicability (Çela et al., 2025; Nguyen & Nguyen, 2024; Yaghoubi Farani et al., 2017). The TPB also has potential limitations in capturing digital-specific entrepreneurial dynamics. For instance, while the TPB provides valuable insights into the impact of individual digi-

tal competencies on entrepreneurial intentions, it may not fully capture the rapidly evolving nature of digital technologies and their influence on entrepreneurial behaviour (Duong et al., 2024; Nguyen & Nguyen, 2024). Moreover, the TPB may not fully account for the indirect effects of entrepreneurial knowledge on digital entrepreneurial intentions, indicating a potential limitation in its ability to comprehensively capture the complex dynamics of digital entrepreneurship (Farani et al., 2017). Yet despite these potential limitations, the authors believe that given the overall characteristics of the TPB, this is the most suitable methodological approach to deal with the research objectives.

Although digital transformation theories explain how technology changes markets and organizations, their focus is on structural change (Hanelt et al., 2021). These perspectives are less successful in explaining the personal motivations and decision-making processes that drive individuals to pursue entrepreneurial endeavours. The TPB provides a perspective that emphasizes the ways in which personal attitudes, perceived control, and social influences affect intentions and actions. The proposed model serves as a framework for comprehending intention formation in digital contexts. It has been adapted to address the conditions of digital entrepreneurship, recognizing that awareness, learning, and an innovative mindset are necessary for engagement in the digital economy. This approach seeks to link digital change to the psychological mechanisms that explain why individuals intend to engage in digital entrepreneurship.

A Digital Entrepreneurship education, Innovative Digital attitude, and Digital Entrepreneurial Intention

Entrepreneurship involves the creation of new combinations of resources to establish innovative organizational types, leading to either radical or incremental changes. The growing integration of digital technologies enabled new collaboration methods, enhanced businesses' capabilities, transformed organizational structures, business processes, and competitive landscapes (Bharadwaj et al., 2013; Shen et al., 2018). The emergence and development of digital technologies enabled, promoted, and facilitated value creation within sustainable business models, helping address social and environmental challenges (Fuerst et al., 2023). Furthermore, digital technologies reshaped the entrepreneurial process and, fuelled by new collaborative methods, transformed traditional business models into innovative ones (Steininger et al., 2022). These new technologies have driven the digital economy, facilitating the rise of new opportunities and greater business potential, along with lower entry costs for startups (Zhao et al., 2015). Hence, as digital technology development proceeds, new ways of doing business emerge, boosting economic growth. Within this context, accelerating digital transformation requires the establishment of genuine centres of innovation and the inspiration and mobilization of partners towards an environment conductive to value creation. However, it also requires education and talent development (Di Vaio et al., 2021; Gaurav & Kongar, 2021; Secundo et al., 2019), which could be achieved through a Digital Entrepreneurship Education policy.

Digital Entrepreneurship Education is a field that integrates innovation, technology, and business education, seeking to provide individuals with the necessary skills

and mindset to thrive in the digital economy (Ndou, 2021; Sitaridis & Kitsios, 2024; Wang et al., 2021), and prepare students to start, manage, and grow business primarily based on digital technologies. Previous studies found that Digital Entrepreneurship Education and entrepreneurship education positively influence entrepreneurial intentions and innovative capabilities, with entrepreneurship acting as an organizational trait contributing to sustainable innovation (Wang et al., 2021; Zhao et al., 2021a). Furthermore, digital entrepreneurship self-efficacy, digital literacy, creativity are significant determinants of digital entrepreneurial intentions among students, indicating that Digital Entrepreneurship Education can enhance the propensity to engage in digital entrepreneurship and digital entrepreneurship impacts innovation systems through a combination of entrepreneur, process, and ecosystem factors, affecting business structures and causing disruptions (Satalkina & Steiner, 2020). Within this context, the use of digital entrepreneurship platforms offer access to tools that foster innovation and digital mindsets (Shen et al., 2018) and, innovative teaching methods and automated tools in entrepreneurship education positively affects the feasibility of business ideas among students, showing that Digital Entrepreneurship Education encourages a proactive and innovative approach to digital tools (Mavlutova et al., 2020), positively influencing students' attitudes towards entrepreneurship, driving a higher propensity to engage in business and desire for independence and achievement (Tóth-Pajor et al., 2023).

Hence, Digital Entrepreneurship Education prepares individuals with the skills, knowledge, and mindset to recognize and pursue digital business opportunities. While previous studies (Mavlutova et al., 2020; Wang et al., 2021) confirm the positive influence of Digital Entrepreneurial Education on entrepreneurial intention, the role of education should be addressed as a dynamic construct interacting with cognitive and motivational factors such as innovative digital attitude. Consequently, the following hypothesis was formulated:

H1a Students' Digital Entrepreneurship Education positively affects the innovative digital attitude

Innovative digital entrepreneurial intention refers to the determination, motivation, and readiness of individuals to create and manage new digital ventures that incorporate innovative approaches and digital technologies (Youssef et al., 2021). This concept plays a central role in the entrepreneurial process by fostering the adoption of digital solutions and the pursuit of opportunity within digital environments. The intention is influenced by various factors including digital competence, innovative cognition, and exposure to entrepreneurial role models, which contribute to shape the mindset and plans necessary for digital entrepreneurship (Mir et al., 2023). Given its focus on developing students' digital, cognitive, and entrepreneurial capabilities, Digital Entrepreneurship Education is expected to positively affect students' innovative digital entrepreneurial intentions. This process leads to strengthening their digital skills, enhancing their ability to think creatively, and promoting self-efficacy and a proactive entrepreneurial mindset (Ahmad et al., 2022; Liu et al., 2019; Mir et al., 2023). Previous studies provide empirical evidence supporting the positive effect of Digital Entrepreneurship Education on students' digital entrepreneurial inten-

tions (Duong et al., 2024; Singh et al., 2024; Vu et al., 2024; Wibowo et al., 2023). However, in some contexts, this relationship may appear weak or non-significant (Gangadhara & Kumar, 2024), suggesting that although a positive link is widely reported, further investigation is needed to clarify boundary conditions and contextual influences. Based on this, the following hypothesis is proposed:

H1b Students Digital Entrepreneurship Education affects positively innovative digital entrepreneurial intention.

Digital Entrepreneurial Knowledge, Innovative Digital Attitude, and Digital Entrepreneurial Intention

Digital Entrepreneurial Knowledge, innovative digital attitude, and Digital Entrepreneurial Intention are interconnected subjects that are critical to entrepreneurship, particularly within the scope of innovation and technology-driven businesses. Digital Entrepreneurial Knowledge involves the understanding and utilization of digital technologies, which are crucial for recognising and exploiting entrepreneurial opportunities (Flowers & Meyer, 2020), while innovative digital attitude refers to an entrepreneur's mindset that favours innovation trough digital technologies (Mir et al., 2023), and Digital Entrepreneurial Intention refers to individuals resolve to start and manage digital businesses (Ben Youssef et al., 2021).

Digital Entrepreneurial Knowledge involves skills and insights related to digital technologies and their applications in entrepreneurial activities. This knowledge can significantly influence students' attitudes towards innovation, as those students who better understand digital tools and platforms will perceive and evaluate innovative opportunities more favourably, fostering a more innovative digital attitude (Scuotto & Morellato, 2013). Furthermore, educational programs that improve students' digital entrepreneurial knowledge have been shown to foster innovative thinking and attitudes.

Therefore, programs that integrate digital skills with entrepreneurial knowledge contribute to developing a mindset conducive to innovation (Wibowo et al., 2023), which suggest that the concept of digital entrepreneurship can reshape students' attitudes towards new and innovative ideas. Furthermore, higher levels of digital literacy knowledge tend to strengthen students' innovative attitudes and students' digital entrepreneurial knowledge positively affects their innovative digital attitude (Alferaih, 2022). Digital Entrepreneurial Knowledge further reflects a student's understanding of digital tools and how they can be applied in entrepreneurship. Previous research has linked Digital Entrepreneurial Knowledge to both entrepreneurial competence and intention (Scuotto & Morellato, 2013; Wibowo et al., 2023). However, its role in fostering innovative attitude remains mostly underexplored, particularly when involving digital attitude. Following this reasoning, the following hypothesis was proposed:

H2a Students' digital entrepreneurial knowledge affects positively innovative digital attitude.

Empirical research has shown that Digital Entrepreneurial Knowledge is a significant predictor of Digital Entrepreneurial Intention, highlighting the importance of targeted educational programs in developing entrepreneurial capacities and intentions among students. Entrepreneurial knowledge and competence can foster students' behaviour towards improving their skills and increase their belief in establishing digital business enterprises (Darmanto et al., 2023), further influencing students' digital entrepreneurial intentions through motivational factors such as attitudes towards entrepreneurship and perceived behavioural control (Yaghoubi Farani et al., 2017). However, entrepreneurial knowledge about digital contexts seems to indirectly affect Digital Entrepreneurial Intention (Yaghoubi Farani et al., 2017).

Digital entrepreneurial knowledge encompasses information and technology capabilities that positively impact the generation of new digital venture ideas (Yao et al., 2021). Furthermore, Digital Entrepreneurship Education fosters entrepreneurial knowledge, significantly promoting students' digital entrepreneurial intentions, particularly educational content addressing digital entrepreneurship, which improves students' intentions to engage in digital ventures, and highlights the role of Digital Entrepreneurial Knowledge in shaping students' intentions (Wibowo et al., 2023). Hence, digital entrepreneurship knowledge, including digital literacy, entrepreneurship education, innovativeness, and creativity, promotes students' digital entrepreneurship intentions (Darmanto et al., 2023; Wibowo & Narmaditya, 2022). Therefore, the following hypothesis was formulated:

H2b Students' digital entrepreneurial knowledge has a positive effect on digital entrepreneurial intention.

2.4. Digital Entrepreneurial alertness, Innovative Digital attitude, and Digital Entrepreneurial Intention

Digital entrepreneurial alertness refers to an entrepreneur's ability to evaluate a digital environment and assess perceived business opportunities and threats. This evaluation requires the recognition of shifts, market trends, technological innovations, and changes, suggesting that Digital Entrepreneurial Alertness is crucial for identifying and capitalizing on digital business opportunities effectively (Wibowo et al., 2023). On the other hand, an innovative digital attitude, enhanced by positive affect, significantly impacts firms' innovation, suggesting that the cognitive processes involved in entrepreneurial alertness — such as information scanning, association, and evaluation — improve the ability to engage in innovative activities. This process indicates that students with high Digital Entrepreneurial Alertness are more likely to engage in digital innovation and entrepreneurship (Levasseur et al., 2022).

Additionally, digital competence, a key trait of digital entrepreneurs and of Digital Entrepreneurial Alertness, positively impacts the dimensions of entrepreneurial alertness: scanning and search, association and connection, and evaluation and judgment, suggesting that increased digital alertness fosters a more innovative approach to handling digital tools and technologies, thereby nurturing an innovative digital attitude (Majeed & Hamed, 2023). Moreover, as previous evidences showed, students' digital

entrepreneurial alertness positively affects their innovative digital attitude (Elnadi & Gheith, 2023).

Whereas entrepreneurial alertness has a solid theoretical foundation (Gaglio & Katz, 2001; Tang et al., 2012) and previous studies showing that entrepreneurial alertness positively affects their innovative digital attitude (Elnadi & Gheith, 2023), the entrepreneurial alertness digital-specific variant still needs further research by integrating TPB-based studies. Hence, the following hypothesis was formulated:

H3a Students' digital entrepreneurial alertness positively affects innovative digital attitude.

While digital entrepreneurial alertness concept results from the entrepreneurial alertness concept, which involves scanning and search, association and connection, and evaluation and judgment in the pursuit of new opportunities (Gaglio & Katz, 2001; Tang et al., 2012), and encompasses the ability of individuals and organizations to identify and capitalize digital opportunities, digital entrepreneurial intention refers to a person's interest in starting a business that leverages digital technologies (Darmanto et al., 2023; Mir et al., 2023). Both concepts are interconnected, with entrepreneurial alertness facilitating businesses model innovation through explorative and exploitative learning (Zhao et al., 2021b), moderating the relationship between Digital Entrepreneurship Education and Digital Entrepreneurial Intention (Wibowo et al., 2023), mediating and regulating role between entrepreneurial education and entrepreneurial intention, and between innovativeness and entrepreneurial intention among university students (Gozukara & Colakoglu, 2016).

The evidence from the interplay between entrepreneurial alertness and entrepreneurial intentions has been acknowledged within scientific literature (Westhead & Solesvik, 2016), with entrepreneurial alertness, as well as entrepreneurial characteristics influencing entrepreneurial intention and digital entrepreneurship intention (Dutot & Horne, 2015; Elnadi & Gheith, 2023; Stanić, 2020). Therefore, the following hypothesis was formulated:

H3b Students digital entrepreneurial alertness positively affects digital entrepreneurial intention.

Innovative Digital Attitude in Digital Entrepreneurial Intention

Innovativeness is generally positively related to digital entrepreneurial intention, with factors such as market orientation, entrepreneurial orientation, learning orientation, entrepreneurship education, and certain personality traits enhancing this relationship. Additionally, the presence of strong leadership and positive affect influences this relationship (Gozukara & Colakoglu, 2016). Innovativeness has the greatest impact on digital entrepreneurial intentions, followed by the presence of role models (Mir et al., 2023). Digital transformation can make enterprises more innovative and their employees more entrepreneurial, allowing them to return to the original Schumpeterian idea of the entrepreneur as an innovator (Upadhyay et al., 2023). Innovativeness and entrepreneurship education have a positive impact on university students' digital

entrepreneurial intentions (Akhter et al., 2022; Elnadi & Gheith, 2023). Therefore, the following hypothesis was formulated:

H4 *Students' innovative digital attitude positively affects digital entrepreneurial intention.*

The Mediating Effect of the Innovative Digital Attitude

Research on the impact of students' innovative digital attitudes on Digital Entrepreneurial Intention has generated considerable attention, with various studies examining the factors that influence students' propensity to engage in digital entrepreneurship. According to Akhter et al. (2022) students' innovativeness and entrepreneurship education have a more significant impact on their digital entrepreneurial intentions. Positive attitudes toward innovation are positively associated with intentions to start their own businesses, partially mediated by attitudes toward the specific object of starting a business (Wurthmann, 2014).

Entrepreneurship education is a field of study that aims to provide individuals with the skills necessary to succeed in starting and managing their own businesses. It encompasses a range of practices and pedagogies designed to develop entrepreneurial skills, knowledge, and intentions (Bae et al., 2014). Action-based entrepreneurship education at universities seem to emphasizes learning by doing, focusing less on individual teaching and more on group and network activities (Rauch & Hulsink, 2015). Entrepreneurship education courses have a positive impact on entrepreneurship in general and student entrepreneurship in particular (Breznitz & Zhang, 2022; Mir et al., 2023; Youssef et al., 2021), and an innovative attitude influences entrepreneurial intentions (Law & Breznik, 2017). On the other hand, digital entrepreneurial self-efficacy acts as a mediator between digital entrepreneurial education and intention. It enhances the positive impact of education on entrepreneurial intentions (Duong et al., 2024; Vu et al., 2024). Hence, within the framework of the TPB, attitudes represent a core mechanism through which external factors influence intention. Innovative digital attitude serves as key construct through which students interpret the value and relevance of Digital Entrepreneurial Education, Digital Entrepreneurial Knowledge, and Digital Entrepreneurial Alertness. TPB posits that behaviour is best predicted by intention, which in turn is shaped by attitudes toward that behaviour, perceived behavioural control, and subjective norms (Ajzen, 1985). Consequently, even when educational or cognitive capabilities are present, their translation into entrepreneurial intentions depends significantly on how favourably the individual evaluates the act of engaging in digital entrepreneurship, an evaluation captured by innovative digital attitude. Accordingly, this study proposes that innovative digital attitude operates as a mediating factor that channels the influence of Digital Entrepreneurial Education, Digital Entrepreneurial Knowledge, and Digital Entrepreneurial Alertness onto digital entrepreneurial intention. This mediation is theoretically justified by TPB, where the formation of a positive attitude towards the behaviour (entrepreneurship) is a step between cognition and intention, a view that is align with previous studies.

Entrepreneurship education aims to develop the competencies and attitudes necessary to initiate and manage entrepreneurial activities. It does not influence intention

solely through content knowledge, but also by shaping affective responses such as students' enthusiasm, creativity, and receptivity to innovation, that form the basis of entrepreneurial attitudes (Bae & Ha, 2014; Law & Breznik, 2017). Programs based on action-learning further reinforce this by embedding students in collaborative and innovative environments (Rauch & Hulsink, 2015). Empirical research shows that while Digital Entrepreneurial Education may not always have a significant direct effect on intention, its impact becomes relevant when mediated by attitudinal variables such as innovative digital attitude (Breznitz & Zhang, 2022; Mir et al., 2023). Hence, the following hypothesis was formulated:

H5 *Digital Entrepreneurship Education in students positively affects digital entrepreneurial intention, when mediated by innovative digital attitude.*

Similarly, digital entrepreneurial knowledge provides students with digital literacy and business expertise, which can enhance their stance towards digital entrepreneurship. Digital entrepreneurial knowledge focuses on the impact of digital knowledge on the entrepreneurial intentions and attitudes of students. Entrepreneurial knowledge is among the most important factors in promoting student entrepreneurship, while informal collaborative networks (Lopes & Franco, 2019; Lopes & Farinha, 2018) and the ability to efficiently use the latest technology also contribute to developing an entrepreneurial attitude (Gomes et al., 2023; Scuotto & Morellato, 2013). However, this influence may be indirect, i.e., operating through students' self-perception's and motivational constructs such attitudes and perceived feasibility. Some studies suggest that entrepreneurial knowledge alone is not always sufficient and that it must lead to favorable evaluations of entrepreneurial behaviour in order to translate intention (Roxas et al., 2008). Others argue that entrepreneurial knowledge has indirect effects on digital entrepreneurial intentions through motivational factors, such as attitudes towards digital entrepreneurship and perceived behavioral control (Farani et al., 2017), or that Digital Entrepreneurship Education fosters students' digital entrepreneurship intentions by mediating the roles of entrepreneurial knowledge and inspiration (Wibowo & Narmaditya, 2022).

Overall, innovative digital attitude seems to act as a mediator between digital entrepreneurial knowledge and digital entrepreneurial intention. This means that the knowledge students gain enhances their innovative attitudes, which in turn boosts their entrepreneurial intentions (Lopes et al., 2025; Wibowo et al., 2023; Zulwisli et al., 2024). Previous research showed that when students possess a strong innovative digital attitude, the impact of their digital entrepreneurial knowledge on their entrepreneurial intentions is amplified (Lopes et al., 2025; Zulwisli et al., 2024). Based on this reasoning, the following hypothesis is formulated:

H6 *Digital entrepreneurial knowledge in students positively affects digital entrepreneurial intention, when mediated by innovative digital attitude.*

Entrepreneurial alertness, defined as the ability to identify, evaluate, and exploit business opportunities, is recognized as a crucial capability in digital entrepreneurship. In digital contexts, digital entrepreneurship alertness allows individuals to scan

the environment for emerging digital trends, associate disparate digital resources, and judge the viability of new opportunities (Gaglio & Katz, 2001; Tang et al, 2012). Closely related to this topic, previous research argued that digital competence and innovative cognition significantly contribute to the propensity to start digital ventures (Biswas & Verma, 2021; Sang & Lin, 2019), and confirmed that digital entrepreneurship alertness is a significant direct predictor of digital entrepreneurial intention (Elnadi & Gheith, 2023; Wibowo et al., 2023), highlighting its role in the early stages of the entrepreneurial decision-making process. However, this relationship is not purely cognitive or informational. Alertness by itself does not guarantee intention unless the student develops a positive evaluative disposition, i.e., an innovative attitude, toward applying digital opportunities in entrepreneurial ways. The innovative digital attitude acts as a cognitive-affective mediator that determines whether the alertness detected is internalized as desirable and feasible for entrepreneurial action (Lopes et al., 2025; Zulwisli et al., 2024). This means students who are more alert to digital opportunities will only act on them if they also possess an attitude that values innovation, perceive these opportunities positively, and leverage their innovative attitude into concrete entrepreneurial actions (Darmanto et al., 2023; Ganefri et al., 2025).This mediating mechanism aligns with the TPB, where attitude is a proximal antecedent of intention (Ajzen, 1985), and personal innovativeness has been shown to enhance the translation of perceptions into intentional behaviour. Furthermore, empirical evidence indicates that the effect of digital entrepreneurship alertness on intention is significantly intensified when mediated by innovative digital attitude, confirming the indirect pathway (Duong, et al., 2024; Lopes et al., 2025). Therefore, digital entrepreneurial alertness serves to develop opportunity recognition, while innovative digital attitude channels this into motivational processes that culminate in intention. Based on this framework, the following hypothesis is suggested:

H7 *Digital entrepreneurial alertness in students positively affects digital entrepreneurial intention, when mediated by innovative digital attitude.*

Figure 1 shows the research model.

Methods

Data and Measurements

The sample for this study was obtained through a questionnaire whose link was published online between September and November 2023 on the authors' social networks and email contacts. This is a sample collected for convenience, not probabilistic. The questionnaire had two cumulative participation conditions: (i) being over 18 years old and currently residing in Portugal, and (ii) being a higher education student in Portugal. 417 participants met these conditions, constituting the final sample. Informed consent was obtained through the questionnaire, and the questionnaire was anonymous. A pre-test was conducted with 12 participants to assess their understanding of the questions and the average response time, with no difficulties

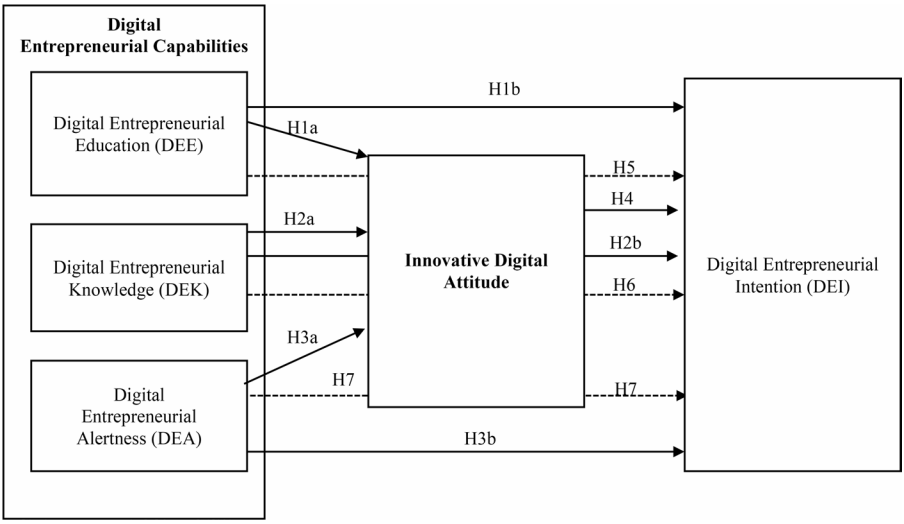

Fig. 1 Research model. Note: Direct effects (→) and mediating effects (⇢)

being recorded by the participants. The results of applying the pre-test demonstrated that the participants understood the questions and had no difficulty in interpreting them, taking an average of six minutes to complete the questionnaire.

The questionnaire consisted of five sections (details in Appendix A.1). The first section pertains to Digital Entrepreneurial Education, comprising five items; the second section pertains to Digital Entrepreneurial Knowledge, also comprising five items; and the third section pertains to Digital Entrepreneurial Alertness, comprising ten items. The items in these three sections were adapted from Wibowo et al. (2023). In turn, Wibowo et al. (2023) had already adopted the items developed by Tang et al. (2012) to measure DEA, and nine items from the study conducted by Hasan et al. (2017) to measure DEE. The fourth section referred to innovative digital attitude with four items adapted from Sobaih and Elshaer (2022), and the fifth section referred to Digital Entrepreneurial Intention with seven items adapted from Wibowo et al. (2023). All items were measured on a five-point Likert scale, ranging from 1 – completely disagree to 5 – completely agree.

Data Analysis

First, a sociodemographic characterization of the participants and a statistical description of the items that measure the constructs were carried out. Afterwards, a factor analysis was conducted, comprising an exploratory factor analysis (EFA) to divide the items into factors and evaluate the commonalities, and a confirmatory factor analysis (CFA) to assess the confirmatory factor loads and the reflective nature of the research model. The Partial Least Squares (PLS) method was then applied to the research model using Smart PLS (V. 4.0). This method combines factor analysis with the estimation of multiple linear regressions, commonly used in similar studies (e.g., Elnadi and Gheith (2023); Abubakre et al. (2022). The model obtained after applying

the PLS method was evaluated in terms of reliability and convergence using the measurements from Hair et al. (2021): Cronbach alpha (Cα > 0.70), Composite Reliability (CR > 0.70) and Average Variance Extracted (AVE > 0.50). Discriminant validity was assessed using the Heterotrait–Monotrait (HTMT) ratio (< 0.85 implying good discriminant validity according to Benitez et al. (2020). The good fit of the model, the relevance of path coefficients, and the predictive and explanatory relevance of the model were also evaluated by R-Square (R^2) and Stone-Geisser measure (Q^2). Collinearity was verified through Variance Inflation Factors (VIF) for all items measuring the constructs (reference values below 5.0, as recommended by Hair et al., 2021). Finally, the relationships established in the research model were estimated through bootstrapping analysis in Smart PLS (V. 4.0). It should be noted that, to minimize the bias in collecting a convenience sample when using the PLS method, two strategies were considered: (i) we applied the "10 times rule", that is, we ensured that we had at least 10 observations per construct with a greater number of indicators and (ii) when applying bootstrapping analysis we use a high number of bootstrap samples (minimum 5,000 for greater robustness) and check the bias of the coefficients by comparing the bootstrap values with the initial estimated values (Dash & Paul, 2021).

In planned cross-national replications, we will ensure comparability via MICOM (measurement invariance of composites) and conduct PLS-MGA for path-wise comparisons across countries; we will also report PLSpredict to assess out-of-sample predictive validity.

Results

Description of the Sociodemographic Characteristics of the Participants

The sample consists of 417 students currently attending higher education in Portugal. Women represent 59% of participants, and men 40.5%. The average age is 21.4, with a minimum age of 18 and a maximum age of 28. The majority of students pursue a bachelor's degree (87.3%), and the remainder are master's and doctoral students.

Description of Item Statistics

Table 1 contains the mean and standard deviation of the items that measure the constructs. On average, participants agreed with the items related to each construct presented in the research model (M > 2.50). Regarding the antecedents of the innovative digital attitude contained in the research model, what, on average, generated the greatest agreement were the items referring to the digital entrepreneurial Alertness construct (M = 3.51), followed by Digital Entrepreneurial Education (M = 2.97) and then from Digital Entrepreneurial Knowledge (M = 2.93). On average, they largely agreed with the Innovative Digital Attitude items (M = 3.75) and demonstrated agreement with the Digital Entrepreneurial Intention items (M = 3.26).

Table 1 Mean and standard deviation of items

Items	Mean	St. Deviation
Digital Entrepreneurial Education (DEE)	2,97	1,046
DEE1	3,00	1,018
DEE2	2,94	1,074
DEE3	2,98	1,052
DEE4	2,99	1,036
DEE5	2,92	1,049
Digital Entrepreneurial Knowledge (DEK)	**2,93**	**1,088**
DEK1	2,80	1,088
DEK2	2,98	1,096
DEK3	2,91	1,056
DEK4	2,99	1,102
DEK5	2,95	1,099
Digital Entrepreneurial Alertness (DEA)	**3,51**	**0,947**
DEA1	3,23	1,028
DEA2	3,11	1,047
DEA3	3,58	0,939
DEA4	3,48	0,928
DEA5	3,66	0,891
DEA6	3,45	0,919
DEA7	3,69	0,953
DEA8	3,65	0,944
DEA9	3,51	0,942
DEA10	3,70	0,878
Innovative Digital Attitude (IDA)	**3,75**	**0,981**
IDA1	3,83	0,982
IDA2	3,76	0,900
IDA3	3,52	1,072
IDA4	3,88	0,970
Digital Entrepreneurial Intention (DEI)	**3,26**	**1,195**
DEI1	3,27	1,202
DEI2	3,59	1,204
DEI3	3,32	1,241
DEI4	3,73	1,124
DEI5	3,07	1,231
DEI6	2,94	1,146
DEI7	2,90	1,214

Factor Analysis

The results of the EFA and CFA are included in Appendix A.2. The implementation of EFA divided the items into five factors, with no item being eliminated. All items showed high communalities (>0.70). The accumulated variance of the factors was 67.92%, with no factor individually presenting a variance greater than 50%. The fact that no single factor explains more than 50% of the variance suggests that there is no significant common method bias according to Harman's Single-Factor Test. The CFA results demonstrate that all items have high confirmatory factor loads (>0.70), and

as such, no items were eliminated. The reflective nature of the research model was also confirmed.

Test of the Reliability, Convergence and Discriminant Validity

The model obtained after applying the PLS algorithm is reliable and convergent since the measures Cronbach alpha (Cα > 0.70), Composite Reliability (CR > 0.70) and AVE (AVE > 0.50) coefficients are higher than the values of reference suggested by Hair et al. (2021) (Table 2). Furthermore, there is also discriminant validity since the correlation ratios obtained are lower than 0.85 (Benitez et al., 2020).

The model also presents a good fit according to the criteria suggested by Hair et al. (2022): Chi-Square ($p = 0.096$), Goodness-of-Fit (0.93; reference > 0.90), the Comparative Fit Index (0.95; reference value > 0.90) and Standard Root Mean Square Residual (0.072; reference value < 0.08). The variance inflation factor (VIF) were calculated in order to assess the possibility of collinearity problems. Variance inflation factor (VIF) was also evaluated to verify the existence of potential collinearity problems. The largest VIF is relative to DEE5 (2,963) wich indicates that there is no evidence of severe multicollinearity between the variables in its model since it is within acceptable standards, according to Hair et al. (2019), where the commonly adopted limit is VIF < 3.3. The R-Square (R^2) was also calculated to evaluate the significance and relevance of path coefficients. According to Cohen (2013) criterion, the dependent variables digital entrepreneurial intention and innovative digital attitude present a "substantial effect" (> 0.26) since the R^2 are 0.536 and 0.394, respectively. The predictive relevance of the estimated model was evaluated by the Stone-Geisser measure (Q^2) and as the Q^2 values obtained for the dependent variables are greater than zero, then the model presents predictive relevance (digital entrepreneurial intention – $Q^2 = 0.350$ and innovative digital attitude – $Q^2 = 0.118$, respectively).

Estimating the Relationships of the Research Model

Tables 3 and 4 contains the results of estimating the direct and mediating effects between the constructs established in the research model.

Beyond statistical significance, we emphasize effect sizes and predictive relevance, noting that IDA → DEI is small (β = 0.098) and DEK/DEA → DEI exhibit comparatively larger standardized effects; conclusions are therefore calibrated to practical (not only statistical) significance.

Table 2 Convergence, reliability and discriminant validity of the measurement model

				HTMT Criterion				
	Cα	CR	AVE	DEE	DEK	DEA	IDA	DEI
Digital Entrepreneurial Education (DEE)	0.916	0.937	0.750					
Digital Entrepreneurial Knowledge (DEK)	0.919	0.939	0.755	0.419				
Digital Entrepreneurial Alertness (DEA)	0.903	0.920	0.534	0.377	0.636			
Innovative Digital Attitude (IDA)	0.797	0.869	0.629	0.173	0.207	0.496		
Digital Entrepreneurial Intention (DEI)	0.916	0.933	0.666	0.296	0.744	0.630	0.342	

Table 3 Direct effects

Direct Effects on Endogenous Variable	Path (β)	t Value (Bootstrap)	*P*-value	Confidence Interval		Hypothesis Support
				2.5%	97.5%	
H1a: Digital Entrepreneurial Education → Innovative Digital Attitude	0.013	0.281	0.008	−0.080	0.103	Yes
H1b: Digital Entrepreneurial Education → Digital Entrepreneurial Intention	−0.030	0.513	0.608	−0.137	0.077	No
H2a: Digital Entrepreneurial Knowledge → Innovative Digital Attitude	0.125	2.221	0.027	0.019	0.251	Yes
H2b: Digital Entrepreneurial Knowledge → Digital Entrepreneurial Intention	0.553	8.264	0.000	0.422	0.688	Yes
H3a: Digital Entrepreneurial Alertness → Innovative Digital Attitude	0.504	7.437	0.000	0.370	0.632	Yes
H3b: Digital Entrepreneurial Alertness → Digital Entrepreneurial Intention	0.229	3.472	0.001	0.112	0.366	Yes
H4: Innovative Digital Attitude → Digital Entrepreneurial Intention	0.098	2.363	0.019	0.016	0.178	Yes

Table 4 Mediating effects

Effects on Endogenous Variable	Path (β)	t Value (Bootstrap)	*P*-value	Confidence Interval		Hypothesis Support
				2.5%	97.5%	
H5: Digital Entrepreneurial Education → Innovative Digital Attitude → Digital Entrepreneurial Intention	0.135	0.280	0.009	0.007	0.212	Yes
H6: Digital Entrepreneurial Knowledge → Innovative Digital Attitude → Digital Entrepreneurial Intention	0.675	1.422	0.006	0.331	0.685	Yes
H7: Digital Entrepreneurial Alertness → Innovative Digital Attitude → Digital Entrepreneurial Intention	0.350	2.168	0.031	0.207	0.397	Yes

The results reveal that digital entrepreneurial education, knowledge, and alertness positively affect innovative digital attitude (β = 0.013; β = 0.125 and β = 0.504, respectively). Digital entrepreneurial alertness is the antecedent that has the greatest influence on innovative digital attitudes, followed by digital entrepreneurial knowledge. In this way, hypotheses H1a, H2a, and H3a are confirmed. However, only digital entrepreneurial knowledge and alertness positively affect digital entrepreneurial intention (β = 0.553 and β = 0.299, respectively), with digital entrepreneurial education not being statistically significant. In this way, hypotheses H2b and H3b are confirmed, and hypotheses H1b are rejected. The results also reveal a positive, albeit residual, influence of innovative digital attitude on digital entrepreneurial intention (β = 0.098), confirming hypothesis H4.

The results of the mediating effects demonstrated that the relationship between digital entrepreneurial education, knowledge, and alertness with digital entrepreneurial intention is more intense when mediated by an innovative digital attitude than

when compared to its direct effect (β = 0.135; β = 0.675 and β = 0.350, respectively). Thus, hypotheses H5 to H7 are confirmed.

Discussion of Results and Implications

Discussion of Results

Our findings indicate modest direct effects alongside stronger associations for knowledge and alertness. In line with best practice, we avoid portraying small coefficients as decisive and instead present the results as incremental evidence within the TPB-based literature on entrepreneurial intentions. This stance is consistent with meta-analyses that typically observe small effects for entrepreneurship education and intention models.

In this aligment, he study show that all the hypotheses of the direct effects are supported, except H5: Digital Entrepreneurship Education in students positively affects Digital Entrepreneurial Intention not corroborating the theory of Farani et al. (2017), based on the assumption that Digital Entrepreneurial Knowledge has an indirect influence on Digital Entrepreneurial Intention, based on motivational factors such as attitudes towards digital entrepreneurship and perceived behavioral control.

Specifically, as shown in Table 3, Hypothesis H1a is confirmed, indicating that Digital Entrepreneurial Education has a direct effect on Innovative Digital Attitude, which aligns with the theoretical framework proposed by Alferaih (2022). In this alignment, we also see the direct influence of Digital Entrepreneurial Knowledge on Innovative Digital Attitude, thus confirming hypothesis H2a, aligning with the argumentation of Scuotto and Morellato (2013), that the influence on students' attitudes towards innovation and Digital Entrepreneurial Intention reflects individuals' resolve to start and manage digital businesses (Ben Youssef et al., 2021). Additionally, students' digital entrepreneurial knowledge has a positive impact on their innovative digital attitude (Alferaih, 2022). In this area, the direct influence of Digital Entrepreneurial Alertness on Innovative Digital Attitude was confirmed, thus confirming hypothesis H3a, reinforcing the arguments of Darmanto et al. (2023) and Mir et al. (2023), digital entrepreneurial intention is defined as an individual's interest in creating a business that leverages digital technologies. Abaddi (2023) and Wibowo et al. (2023) argue for the transformative impact of Digital Entrepreneurship Education, Digital Entrepreneurial Alertness, and Digital Entrepreneurial Knowledge in shaping individuals' attitudes, behaviours, and outcomes in the field of digital entrepreneurship and entrepreneurial intention.

The results show that digital education does not have a significant direct effect on the intention to adopt (H1b not supported). This suggests that the mere acquisition of digital skills or training is not, by itself, sufficient to directly influence adoption behaviors. Its impact appears to operate indirectly, particularly through innovative attitude, which emerges as a relevant mediating variable. Thus, digital education may strengthen internal predispositions toward change without necessarily generating immediate behavioral intention. Hypothesis H2b is also supported in our study. Thus, digital entrepreneurship knowledge, encompassing digital literacy, entrepreneurship

education, innovativeness, and creativity, enhances students' digital entrepreneurial intentions (Darmanto et al., 2023; Wibowo & Narmaditya, 2022).

These patterns may be partially context-dependent, given Portugal's cultural profile and higher-education arrangements. Cross-national evidence indicates that culture moderates TPB paths and intention models; thus, the Portuguese setting may help explain the weak direct education→intention link observed here (Liñán & Fernandez-Serrano, 2014; Schlaegel & Koenig, 2014).

In this alignment, our study also supported hypotheses H3b, and H4. The relationship between entrepreneurial alertness and entrepreneurial intentions has been recognized in the scientific literature (Westhead & Solesvik, 2016), with entrepreneurial alertness, along with entrepreneurial characteristics, influencing both entrepreneurial intention and digital entrepreneurship intention (Dutot & Horne, 2015; Stanić, 2020; Elnadi & Gheith, 2023). Regarding perceived value (H4), the direct effect on intention is statistically significant but weak ($\beta = 0.098$). This indicates that the perceived benefits of digital adoption may have some influence on the decision, though not as a decisive factor on their own. Entrepreneurship education courses have a positive impact on entrepreneurship in general, and student entrepreneurship in particular (Breznitz & Zhang, 2022; Mir et al., 2023; Youssef et al., 2021), with an innovative attitude significantly influencing entrepreneurial intentions (Law & Breznik, 2017). In the context of digital entrepreneurship, education in this area promotes students' digital entrepreneurial intentions, mediated by entrepreneurial knowledge and inspiration (Wibowo & Narmaditya, 2022).

Innovative attitude, in turn, shows a positive and statistically significant effect on adoption intention (H5), as well as a partial mediating role in the relationships between antecedent factors and intention (H6–H7). Although the observed coefficients (e.g., $\beta = 0.135$ for H5) are of moderate magnitude, these results highlight the importance of individual dispositions as enablers of digital transition. However, the role of innovative attitude should not be overstated — it is a meaningful but limited contribution within a multifactorial model. Overall, the results reinforce the need to consider indirect paths and mediating mechanisms when analyzing the adoption of digital practices. The effects observed are consistent with the literature, but their magnitude calls for a cautious interpretation regarding practical significance. Additionally, entrepreneurial alertness plays a significant mediating and regulating role between entrepreneurial education and entrepreneurial intention among university students (Biswas & Verma, 2021; Sang & Lin, 2019). This confirms, respectively, that Digital Entrepreneurship Education in students positively affects Digital Entrepreneurial Intention, when mediated by Attitude; that Digital Entrepreneurial Knowledge in students positively affects Attitude, when mediated by Attitude; and that Digital Entrepreneurial Alertness in students positively affects Digital Entrepreneurial Intention when mediated by Attitude.

Theoretical Implications

In our study, the mediating effects clarified the mechanisms through which Digital Entrepreneurship Education relates to Digital Entrepreneurial Intention. Specifically, they rendered the relationship between education and intention statistically signifi-

cant and enhanced the associations of Digital Entrepreneurial Alertness and Digital Entrepreneurial Knowledge with intention. These findings are consistent with previous studies (Wibowo et al., 2023; Zainal & Yong, 2020) reinforcing the idea that Digital Entrepreneurship Education contributes to the development of innovative attitudes and entrepreneurial orientation among students, primarily through indirect pathways.

From a theoretical perspective, the results suggest that Digital Entrepreneurial Alertness operates as a relevant mediator between education, knowledge, and intention. Likewise, entrepreneurial knowledge — whether general or digitally focused — appears to enhance the effect of education on intention. However, as highlighted in earlier research (Bae et al., 2014; Breznitz & Zhang, 2022) digital skills and literacy alone may have limited or even negative effects when not combined with entrepreneurial attention and education, which may help explain the absence of a direct effect in our model.

Rather than asserting a transformative impact, our findings offer incremental insights into how existing constructs interact, particularly through the roles of alertness and technological self-efficacy as mediating and moderating variables. While these results underline the potential value of embedding Digital Entrepreneurship Education within academic curricula (Akhter et al., 2022; Wibowo et al., 2023), more specific and evidence-based recommendations for educators and policymakers remain necessary.

Practical Implications

The results of this study reinforce that digital entrepreneurship is a current and dynamic field within entrepreneurship, characterized by the use of digital technologies to start and manage new businesses (entrepreneurial activity).

Bridging theory and practice with concrete, low-cost actions. To translate our constructs into practice under modest effect sizes, we suggest three short, scalable activities that map onto our model (DEE/DEK/DEA → IDA → DEI): (1) 2-week Opportunity-Recognition Mini-Sprint using the three alertness components (scanning/association/evaluation) with pre–post measures of DEA/IDA/DEI; (2) 48-hour University–Industry Hackathon + 4-week follow-through (mentored sprints to move from prototype to user feedback), which reliably builds applied skills and intention; (3) 4–8-week Action-based Micro-Module (weekly goals, feedback, reflection) shown to strengthen action regulation and entrepreneurial outcomes. These activities are supported by evidence that entrepreneurship programmes and action-based training raise attitudes and/or intentions, and that hackathons accelerate prototyping and learning, making them suitable, incremental bridges from theory to practice in our context (Gielnik et al., 2015; Komssi et al., 2015; Souitaris et al., 2007; Tang et al., 2012).

It is also observed that experimental entrepreneurship education and the use of digital tools in education are effective approaches to increasing Digital Entrepreneurial Intention. The role of Digital Entrepreneurship Education extends beyond trans-

mitting knowledge to inspiring and motivating students towards entrepreneurship, which can positively influence Digital Entrepreneurial Intention. However, regarding practical implications, it is essential not to overlook the importance of integrating Digital Entrepreneurship Education into academic curricula to strengthen Digital Entrepreneurial Intention and promote the emergence of new digital entrepreneurs (Akhter et al., 2022; Wibowo et al., 2023).

Digital entrepreneurship education is an emerging area that intersects with the rapid digital transformation of the economy and society. It focuses on equipping students with the skills and mindset necessary to thrive in the digital age, whether by creating new ventures or innovating in existing businesses (Breznitz & Zhang, 2022; Wibowo et al., 2023). In this way, several relevant recommendations can be proposed for higher education curricula to enhance students' digital entrepreneurial capabilities, particularly with a focus on addressing current challenges and integrating emerging technologies, such as digital tools and Artificial Intelligence (AI).

Institutions should avoid limiting digital entrepreneurship education to business or technology courses alone; instead, they should integrate it into various academic fields. This process will enable students to develop a comprehensive understanding of how digital innovation intersects with various sectors. By combining this knowledge with workshops, simulations, and collaborative work with industry experts, students will be better equipped to increase their digital entrepreneurial awareness (Lopes & Lussuamo, 2021). Additionally, regularly updating curricula to incorporate the latest trends and advancements in digital technology is crucial. This involves challenging students to think creatively and develop innovative solutions to contemporary problems, while also utilizing AI-based educational tools to personalize learning experiences. Incorporating digital collaboration tools, such as virtual classrooms and project management software, can facilitate teamwork and remote collaboration, enabling sustained entrepreneurial initiatives (Elia et al., 2020).

Furthermore, it is essential to integrate digital entrepreneurial knowledge with practical applications, such as hands-on projects and case studies, complemented by modules on AI, machine learning, and other emerging technologies, enabling students to apply their knowledge in real-world scenarios. On the other hand, utilizing AI for market analysis, customer segmentation, and personalized marketing strategies enhances students' ability to recognize and capitalize on digital opportunities, resulting in a more efficient, adaptable, and effective educational model (Chang et al., 2022).

To support more effective implementation, we recommend that higher education institutions integrate Digital Entrepreneurship Education into existing programs through project-based learning, digital venture simulations, and the use of real-world entrepreneurial case studies. Emphasis should be placed not only on digital tools and skills, but also on fostering entrepreneurial alertness and self-efficacy through mentoring, interdisciplinary teamwork, and iterative feedback. For policymakers, we suggest incentivizing partnerships between universities, tech incubators, and digital startups to ensure that curricular content remains aligned with current market

dynamics and emerging technologies, including AI. These steps can help translate educational inputs into meaningful entrepreneurial outcomes, especially when complemented by longitudinal monitoring of graduate ventures.

Given the small yet significant effects (e.g., IDA → DEI), practitioners should expect incremental gains from educational and attitudinal interventions. Priority should be given to low-cost, scalable actions (e.g., brief opportunity-recognition drills and targeted mentoring) rather than high-stakes curricular overhauls, and success metrics should track marginal improvements (participation, prototype submissions, early venture intent) rather than large short-term jumps in firm creation. This calibration follows recommendations to privilege practical significance and predictive performance over sole reliance on p-values.

Limitations of the Study and Future Lines of Research

This study has limitations. The sample was collected for convenience and is non-probabilistic.

Regarding cultural and educational context as boundary conditions, our evidence derives from Portuguese higher-education students and therefore reflects Portugal's cultural values and a binary higher-education system (universities vs. polytechnics) with a strong applied orientation. Prior cross-national work shows that cultural values systematically shape Theory of Planned Behavior (TPB) paths and entrepreneurial-intention models, which can amplify or dampen education-, attitude-, and knowledge-related effects. Consequently, we treat national culture and system features as boundary conditions for our findings—especially the non-significant direct effect of digital entrepreneurial education on intention reported here—and urge caution when generalizing beyond Portugal until cross-national validation is conducted (Kyriakopoulos et al., 2024; Liñán & Fernandez-Serrano, 2014; Schlaegel & Koenig, 2014).

About, cross-validation across cultural–educational settings, to assess generalizability, we propose a multi-site cross-validation using identical instruments and analysis in: (i) Spain (adjacent Latin Europe context), (ii) a Lusophone non-EU setting (e.g., Brazil) to hold language constant while varying institutions, and (iii) high digital-skills contexts in Northern Europe (e.g., Finland/Netherlands). For each site, establish measurement invariance with the MICOM procedure and compare structural paths via PLS-MGA; if using CB-SEM, conduct multi-group invariance tests. Add PLSpredict (holdout-based predictive assessment) to evaluate out-of-sample performance. These steps are current best-practice for valid cross-group comparisons and predictive assessment in variance-based SEM (Henseler et al., 2016; Liengaard, 2024; Shmueli et al., 2019).

As such, the results cannot be generalized. Although the sample was non-probabilistic, the bootstrapping technique was used with a larger number of subsamples (>5,000) in the Smart PLS software to reduce potential biases in the estimation of the model parameters. Bootstrapping analysis allows confidence intervals to be obtained and statistical significance to be tested in a robust manner, even in con-

texts with small samples or samples that do not follow normal distributions. This increases the reliability of the inferences made from the available data. In future studies, a probabilistic sample representative of higher education students in Portugal is recommended. Furthermore, the students' areas of study were not collected, and as such, this information can be used as a moderating variable in the proposed research model. This area of study is gaining traction as it becomes increasingly relevant in a world where digital transformation is reshaping economies and business practices. Regarding future lines of research in this field of knowledge, we would highlight the exploration of the influence of digital transformation on business theory and education, the development of dynamic models that reflect the digital landscape, and participation in interdisciplinary research that bridges the technological, economic, and social dimensions. Moreover, while the study's robust methodology and clear focus on digital entrepreneurship provide relevant insights, no specific hypotheses regarding students' characteristics were formulated in this study. Therefore, future research could also conduct a deeper analysis of students' demographic factors such as age or degree level. It would also be interesting to use control variables such as area of study and previous entrepreneurial experience compared with the results obtained in this study.

Finally, our conclusions explicitly reflect effect magnitudes: the observed coefficients warrant cautious generalization and practitioner expectations focused on incremental impact. Future studies should report effect sizes and out-of-sample predictive accuracy (PLSpredict) to strengthen claims of practical relevance.

Conclusion

This study aims to explore the influence of digital entrepreneurial capabilities on the innovative digital attitude and digital entrepreneurial intention of Portuguese higher education students.

The results demonstrated that digital entrepreneurial knowledge and alertness have a positive influence on the innovative digital attitude of higher education students and their digital entrepreneurial intention. Digital entrepreneurial education has a positive impact on the innovative digital attitude of these students, but not on their digital entrepreneurial intention. However, the association between digital entrepreneurial capabilities and digital entrepreneurial intention is stronger when mediated by an innovative digital attitude. In this way, the important role of digital entrepreneurial education, knowledge, and alertness as antecedents of the innovative digital attitude is reinforced, and the important role of this attitude in boosting digital entrepreneurship. Digital entrepreneurship and digital innovation are not distinct fields of investigation, they present interactions that can be captured through individuals' digital entrepreneurial capabilities.

Appendix

A.1. Questionnaire available at: https://drive.google.com/file/d/1pR7sZdaEavz5AriKG4rVTB6Vz5b3wCDM/view?usp=drive_link.

Table 5 A.2. EFA and CFA results

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Commonalities	Confirmatory Factor Loads
Digital Entrepreneurship Education (DEE)							
DEE1	0.730					0.596	0.787
DEE2	0.870					0.794	0.882
DEE3	0.862					0.795	0.895
DEE4	0.877					0.810	0.890
DEE5	0.854					0.777	0.871
Digital Entrepreneurship Knowledge (DEK)							
DEK1		0.765				0.702	0.835
DEK2		0.728				0.675	0.848
DEK3		0.804				0.786	0.904
DEK4		0.787				0.708	0.865
DEK5		0.812				0.768	0.891
Digital Entrepreneurship Alertness (DEA)							
DEA1			0.711			0.575	0.739
DEA2			0.760			0.576	0.753
DEA3			0.758			0.539	0.746
DEA4			0.774			0.515	0.709
DEA5			0.786			0.540	0.782
DEA6			0.753			0.561	0.780
DEA7			0.802			0.719	0.794
DEA8			0.779			0.685	0.761
DEA9			0.762			0.656	0.742
DEA10			0.793			0.570	0.794
Innovative Digital Attitude (IDA)							
IDA1				0.804		0.753	0.838
IDA2				0.829		0.752	0.858
IDA3				0.652		0.493	0.781
IDA4				0.757		0.717	0.860
Digital Entrepreneurship Intention (DEI)							
DEI1					0.742	0.674	0.825
DEI2					0.776	0.692	0.762
DEI3					0.721	0.744	0.854
DEI4					0.763	0.715	0.742
DEI5					0.726	0.766	0.874
DEI6					0.715	0.667	0.799
DEI7					0.721	0.736	0.848

Authors' Contribution JL and SG conceived the core idea of the manuscript and conducted empirical studies, analyzed the data, and drafted the manuscript. LF and CS helped with the literature review, discussion, and conclusion. All authors have read and approved the manuscript.

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Data Availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethical Conduct Written consent was obtained from all the participants involved in the study.

Conflict of interest The authors declare no potential conflicts of interest.

References

Abaddi, S. (2023). Digital skills and entrepreneurial intentions for final-year undergraduates: Entrepreneurship education as a moderator and entrepreneurial alertness as a mediator. *Management & Sustainability: An Arab Review*. https://doi.org/10.1108/msar-06-2023-0028

Abubakre, M., Zhou, Y., & Zhou, Z. (2022). The impact of information technology culture and personal innovativeness in information technology on digital entrepreneurship success. *Information Technology & People*, *35*(1), 204–231. https://doi.org/10.1108/ITP-01-2020-0002

Adabre, M. A., Chan, A. P. C., Darko, A., & Hosseini, M. R. (2023). Facilitating a transition to a circular economy in construction projects: Intermediate theoretical models based on the theory of planned behaviour. *Building Research & Information, 51*(1), 85–104. https://doi.org/10.1080/09613218.2022.2067111

Ahmad, K. S., Abdul Rahim, N., Abd Samad, K., Mohamad, M. S., & Juhari, J. (2022). Assessing factors of digital entrepreneurial intention among young generation. *International Journal of Academic Research in Business and Social Sciences, 12*(10), 1284–1295. https://doi.org/10.6007/ijarbss/v12-i10/14995

Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behavior. In J. Kuhl & J. Beckmann (Eds.), *Action Control: From Cognition to Behavior* (pp. 11–39). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-69746-3_2

Akhter, A., Islam, K., Karim, M. M., & Latif, W. (2022). Examining determinants of digital entrepreneurial intention: A case of graduate students. *Problems and Perspectives in Management, 20*(3), 153–163.

Alferaih, A. (2022). Starting a new business? Assessing university students' intentions towards digital entrepreneurship in Saudi Arabia. *International Journal of Information Management Data Insights, 2*(2), Article 100087. https://doi.org/10.1016/j.jjimei.2022.100087

Al Halbusi, H., Soto-Acosta, P., & Popa, S. (2023). Analysing e-entrepreneurial intention from the theory of planned behaviour: The role of social media use and perceived social support. *International Entrepreneurship and Management Journal, 19*(4), 1611–1642. https://doi.org/10.1007/s11365-023-00866-1

Al-Mamary, Y. H. S., & Alraja, M. M. (2022). Understanding entrepreneurship intention and behavior in the light of TPB model from the digital entrepreneurship perspective. *International Journal of Information Management Data Insights, 2*(2), Article 100106. https://doi.org/10.1016/j.jjimei.2022.100106

Anim-Yeboah, S., Boateng, R., Awuni Kolog, E., Owusu, A., & Bedi, I. (2020). Digital Entrepreneurship in Business Enterprises: A Systematic Review. In M. Hattingh, M. Matthee, H. Smuts, I. Pappas, Y. K. Dwivedi, & M. Mäntymäki, *Responsible Design, Implementation and Use of Information and Communication Technology* Cham.

Antonizzi, J., & Smuts, H. (2020). The Characteristics of Digital Entrepreneurship and Digital Transformation: A Systematic Literature Review. In M. Hattingh, M. Matthee, H. Smuts, I. Pappas, Y. K. Dwivedi, & M. Mäntymäki, *Responsible Design, Implementation and Use of Information and Communication Technology* Cham.

Armitage ,C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology, 40*(4), 471–499. https://doi.org/10.1348/014466601164939

Bae, T. J., Qian, S., Miao, C., & Fiet, J. O. (2014). The relationship between entrepreneurship education and entrepreneurial intentions: A meta–analytic review. *Entrepreneurship Theory and Practice, 38*(2), 217–254. https://doi.org/10.1111/etap.12095

Benitez, J., Henseler, J., Castillo, A., & Schuberth, F. (2020). How to perform and report an impactful analysis using partial least squares: Guidelines for confirmatory and explanatory IS research. *Information & Management, 57*(2), Article 103168. https://doi.org/10.1016/j.im.2019.05.003

Ben Youssef, A., Boubaker, S., Dedaj, B., & Carabregu-Vokshi, M. (2021). Digitalization of the economy and entrepreneurship intention. *Technological Forecasting and Social Change, 164*, Article 120043. https://doi.org/10.1016/j.techfore.2020.120043

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *MIS Quarterly*. https://doi.org/10.25300/MISQ/2013/37:2.3

Biswas, A., & Verma, R. K. (2021). Attitude and alertness in personality traits: A pathway to building entrepreneurial intentions among university students. *The Journal of Entrepreneurship, 30*(2), 367–396. https://doi.org/10.1177/09713557211025656

Breznitz, S. M., & Zhang, Q. (2022). Entrepreneurship education and firm creation. *Regional Studies, 56*(6), 940–955. https://doi.org/10.1080/00343404.2021.1878127

Burak, L. J. (2002). Predicting Elementary School Teachers' Intentions to Teach Health Education: An application of the Theory of Planned Behavior. *American Journal of Health Education, 33*(1), 4–9. https://doi.org/10.1080/19325037.2002.10604713

Chang, Q., Pan, X., Manikandan, N., & Ramesh, S. (2022). Artificial intelligence technologies for teaching and learning in higher education. *International Journal of Reliability, Quality and Safety Engineering, 29*(05), 2240006. https://doi.org/10.1142/s021853932240006x

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Routledge. https://doi.org/10.4324/9780203771587

Darmanto, S., Ekopriyono, A., Hikmah, & Tri Ratnawati, A. (2023). Investigating the development of entrepreneurial behavior among nascent digital entrepreneurs. *Cogent Business & Management*, *10*(2), 2247875. https://doi.org/10.1080/23311975.2023.2247875

Dash, G., & Paul, J. (2021). CB-SEM vs PLS-SEM methods for research in social sciences and technology forecasting. *Technological Forecasting and Social Change, 173*, Article 121092. https://doi.org/10.1016/j.techfore.2021.121092

Di Vaio, A., Palladino, R., Pezzi, A., & Kalisz, D. E. (2021). The role of digital innovation in knowledge management systems: A systematic literature review. *Journal of Business Research, 123*, 220–231. https://doi.org/10.1016/j.jbusres.2020.09.042

Duong, C. D., Ngo, T. V. N., Nguyen, T. P. T., Tran, N. M., & Pham, H. T. (2024). Digital entrepreneurial education and digital entrepreneurial intention: A moderated mediation model. *Social Sciences & Humanities Open, 10*, 101178. https://doi.org/10.1016/j.ssaho.2024.101178

Dutot, V., & Horne, C. V. (2015). Digital entrepreneurship intention in a developed vs. emerging country: An exploratory study in France and the UAE. *Transnational Corporations Review, 7*(1), 79–96. https://doi.org/10.5148/tncr.2015.7105

Çela, A., Mansi, E., & Morina, F. (2025). Young adults' pathway to digital entrepreneurship: From ideas to innovation. *European Journal of Innovation Management, 28*(7), 2909–2939. https://doi.org/10.1108/EJIM-04-2024-0486

Elia, G., Margherita, A., & Passiante, G. (2020). Digital entrepreneurship ecosystem: How digital technologies and collective intelligence are reshaping the entrepreneurial process. *Technological Forecasting and Social Change, 150*, 119791. https://doi.org/10.1016/j.techfore.2019.119791

Elnadi, M., & Gheith, M. H. (2023). The role of individual characteristics in shaping digital entrepreneurial intention among university students: Evidence from Saudi Arabia. *Thinking Skills and Creativity, 47*, Article 101236. https://doi.org/10.1016/j.tsc.2023.101236

European Commission (2023). *Portugal in the Digital Economy and Society Index*. European Commission. Retrieved April 24, 2024 from https://digital-strategy.ec.europa.eu/en/policies/desi-portugal

Farani, A., Karimi, S., & Motaghed, M. (2017). The role of entrepreneurial knowledge as a competence in shaping Iranian students' career intentions to start a new digital business. *European Journal of Training and Development*, *41*(1), 83–100. https://doi.org/10.1108/EJTD-07-2016-0054

Fauzi, M. A., Hanafiah, M. H., & Kunjuraman, V. (2024). Tourists' intention to visit green hotels: Building on the theory of planned behaviour and the value-belief-norm theory. *Journal of Tourism Futures, 10*(2), 255–276. https://doi.org/10.1108/JTF-01-2022-0008

Flowers, S., & Meyer, M. (2020). How can entrepreneurs benefit from user knowledge to create innovation in the digital services sector? *Journal of Business Research*, *119*, 122–130. https://doi.org/10.1016/j.jbusres.2020.01.025

Fuerst, S., Sanchez-Dominguez, O., & Rodriguez-Montes, M. A. (2023). The role of digital technology within the business model of sustainable entrepreneurship. *Sustainability, 15*(14), Article 10923. https://doi.org/10.3390/su151410923

Gaglio, C. M., & Katz, J. A. (2001). The psychological basis of opportunity identification: Entrepreneurial alertness. *Small Business Economics, 16*(2), 95–111. https://doi.org/10.1023/A:1011132102464

Ganefri, W., Trisno, B., Nordin, N. M., Hidayat, H., Rahmawati, Y., & Nurhidayatulloh (2025). Cultivating digital entrepreneurs: Unravelling factors shaping digital entrepreneurship intention among engineering students in higher education. *The International Journal of Management Education*, *23*(2), 101100. https://doi.org/10.1016/j.ijme.2024.101100

Gangadhara, H., & Kumar, J. S. (2024). Integrated model perspective of capital theory, TPB and SCCT towards determining business students' digital entrepreneurial intention in developing country context. *The Journal of High Technology Management Research, 35*(2), 100519. https://doi.org/10.1016/j.hitech.2024.100519

Gaurav, J., & Kongar, E. (2021). Value creation via accelerated digital transformation. *IEEE Engineering Management Review, 49*(2), 63–72. https://doi.org/10.1109/EMR.2021.3054813

Gielnik, M. M., Frese, M., Kahara-Kawuki, A., Wasswa Katono, I., Kyejjusa, S., Ngoma, M., & Dlugosch, T. J. (2015). Action and action-regulation in entrepreneurship: Evaluating a student training for promoting entrepreneurship. *Academy of Management Learning & Education, 14*(1), 69–94. https://doi.org/10.5465/amle.2012.0107

Godin, G., & Kok, G. (1996). The theory of planned behavior: A review of its applications to health-related behaviors. *American Journal of Health Promotion, 11*(2), 87–98. https://doi.org/10.4278/0890-1171-11.2.87

Goh, E. (2009). Public education and parents: Eliciting salient beliefs using the theory of planned behaviour as a qualitative research framework. *International Review on Public and Nonprofit Marketing*, *6*(2), 99–108. https://doi.org/10.1007/s12208-009-0024-y

Gomes, S., & Lopes, J. M. (2023). The Transformational Impact of Digital Venture Ecosystems on Entrepreneurship in Europe. In J. J. Ferreira & P. J. Murphy (Eds.), *Bleeding-Edge Entrepreneurship: Digitalization, Blockchains, Space, the Ocean, and Artificial Intelligence* (Vol. 16, pp. 91–116). Emerald Publishing Limited. https://doi.org/10.1108/S2040-724620230000016006

Gomes, S., Lopes, J. M., Ferreira, L., & Oliveira, J. (2023). Science and technology parks: Opening the pandora's box of regional development. *Journal of the Knowledge Economy*, *14*(3), 2787–2810. https://doi.org/10.1007/s13132-022-00995-y

Gomes, S., Lopes, J. M., & Trancoso, T. (2024). The green seed: The influence of pro-sustainable orientation on social entrepreneurship in higher education students. *Industry and Higher Education, 0*(0), Article 09504222241297550. https://doi.org/10.1177/09504222241297550

Gordon-Wilson, S., & Modi, P. (2015). Personality and older consumers' green behaviour in the UK. *Futures*, *71*, 1–10. https://doi.org/10.1016/j.futures.2015.05.002

Gozukara, I., & Colakoglu, N. (2016). Enhancing entrepreneurial intention and innovativeness of university students: The mediating role of entrepreneurial alertness. *International Business Research*, *9*(2), 34–45. https://doi.org/10.5539/ibr.v9n2p34

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial least squares structural equation modeling (PLS-SEM) using R: A workbook*. Springer Nature. https://doi.org/10.1007/978-3-030-80519-7

Hanelt, A., Bohnsack, R., Marz, D., & Antunes Marante, C. (2021). A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change. *Journal of Management Studies*, *58*(5), 1159–1197. https://doi.org/10.1111/joms.12639

Hasan, S. M., Khan, E. A., & Nabi, M. N. U. (2017). Entrepreneurial education at university level and entrepreneurship development. *Education + Training, 59*(7/8), 888–906. https://doi.org/10.1108/ET-01-2016-0020

Henseler, J., Ringle, C. M., & Sarstedt, M. (2016). Testing measurement invariance of composites using partial least squares. *International Marketing Review, 33*(3), 405–431. https://doi.org/10.1108/imr-09-2014-0304

Heuer, A., & Kolvereid, L. (2014). Education in entrepreneurship and the theory of planned behaviour. *European Journal of Training and Development*, *38*(6), 506–523. https://doi.org/10.1108/EJTD-02-2013-0019

Honig, B., & Samuelsson, M. (2021). Business planning by intrapreneurs and entrepreneurs under environmental uncertainty and institutional pressure. *Technovation, 99*, Article 102124. https://doi.org/10.1016/j.technovation.2020.102124

INE (2023). *Sociedade da Informação e do Conhecimento - Inquérito à Utilização de Tecnologias da Informação e da Comunicação nas Famílias*. Instituto Nacional de Estatística (INE). Retrieved April 24, 2024 from https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_destaques&DESTAQUESdest_boui=637872566&DESTAQUESmodo=2

ITA (2024). *Information and Communications Technology*. International Trade Administration (ITA). Retrieved April 24, 2024 from https://www.trade.gov/country-commercial-guides/portugal-information-and-communications-technology

Kautonen, T., van Gelderen, M., & Fink, M. (2015). Robustness of the Theory of Planned Behavior in predicting entrepreneurial intentions and actions. *Entrepreneurship Theory and Practice, 39*(3), 655–674. https://doi.org/10.1111/etap.12056

Kautonen, T., van Gelderen, M., & Tornikoski, E. T. (2013). Predicting entrepreneurial behaviour: A test of the theory of planned behaviour. *Applied Economics, 45*(6), 697–707. https://doi.org/10.1080/00036846.2011.610750

Khan, Y., Hameed, I., & Akram, U. (2023). What drives attitude, purchase intention and consumer buying behavior toward organic food? A self-determination theory and theory of planned behavior perspective. *British Food Journal*, *125*(7), 2572–2587. https://doi.org/10.1108/BFJ-07-2022-0564

Khare, A. (2015). Antecedents to green buying behaviour: A study on consumers in an emerging economy. *Marketing Intelligence & Planning*, *33*(3), 309–329. https://doi.org/10.1108/MIP-05-2014-0083

Kollmann, T., Kleine-Stegemann, L., de Cruppe, K., & Then-Bergh, C. (2022). Eras of digital entrepreneurship. *Business & Information Systems Engineering, 64*(1), 15–31. https://doi.org/10.1007/s12599-021-00728-6

Komssi, M., Pichlis, D., Raatikainen, M., Kindstrom, K., & Jarvinen, J. (2015). What are hackathons for? *IEEE Software*, *32*(5), 60–67. https://doi.org/10.1109/ms.2014.78

Kraus, S., Palmer, C., Kailer, N., Kallinger, F. L., & Spitzer, J. (2019). Digital entrepreneurship. *International Journal of Entrepreneurial Behavior & Research, 25*(2), 353–375. https://doi.org/10.1108/IJEBR-06-2018-0425

Krueger, N. F., & Carsrud, A. L. (1993). Entrepreneurial intentions: Applying the theory of planned behaviour. *Entrepreneurship & Regional Development, 5*(4), 315–330. https://doi.org/10.1080/08985629300000020

Kyriakopoulos, P., Herbert, K., & Piperopoulos, P. (2024). I am passionate therefore I am: The interplay between entrepreneurial passion, gender, culture and intentions. *Journal of Business Research, 172*, Article 114409. https://doi.org/10.1016/j.jbusres.2023.114409

Law, K. M. Y., & Breznik, K. (2017). Impacts of innovativeness and attitude on entrepreneurial intention: among engineering and non-engineering students. *International Journal of Technology and Design Education, 27*(4), 683–700. https://doi.org/10.1007/s10798-016-9373-0

Leeuw, A., Valois, P., Ajzen, I., & Schmidt, P. (2015). Using the theory of planned behavior to identify key beliefs underlying pro-environmental behavior in high-school students: Implications for educational interventions. *Journal of Environmental Psychology, 42*, 128–138. https://doi.org/10.1016/j.jenvp.2015.03.005

Levasseur, L., Tang, J., Karami, M., Busenitz, L., & Kacmar, K. M. (2022). Increasing alertness to new opportunities: The influence of positive affect and implications for innovation. *Asia Pacific Journal of Management*, *39*(1), 27–49. https://doi.org/10.1007/s10490-020-09724-y

Liengaard, B. (2024). Measurement invariance testing in partial least squares structural equation modeling. *Journal of Business Research, 177*, Article 114581. https://doi.org/10.1016/j.jbusres.2024.114581

Liñán, F., & Fernandez-Serrano, J. (2014). National culture, entrepreneurship and economic development: Different patterns across the European Union. *Small Business Economics, 42*(4), 685–701. https://doi.org/10.1007/s11187-013-9520-x

Li, S., Bu, Y., Zhang, Z., & Huang, Y. (2024). Digital entrepreneurship intention and digital entrepreneurship behavior: The mediating role of managing learning and entrepreneurship education. *Education + Training*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/ET-05-2023-0176

Liu, X., Lin, C., Zhao, G., & Zhao, D. (2019). Research on the effects of entrepreneurial education and entrepreneurial self-efficacy on college students' entrepreneurial intention. *Frontiers in Psychology, 10*, 1–9. https://doi.org/10.3389/fpsyg.2019.00869

Li, Z. (2024). Navigating digital transformation: A risk-based approach for industry 4.0 innovation. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-024-02264-6

Lopes, J., & Franco, M. (2019). Review about regional development networks: An ecosystem model proposal. *Journal of the Knowledge Economy*, *10*(1), 275–297. https://doi.org/10.1007/s13132-017-0464-2

Lopes, J., & Lussuamo, J. (2021). Barriers to university-industry cooperation in a developing region. *Journal of the Knowledge Economy, 12*(3), 1019–1035. https://doi.org/10.1007/s13132-020-00646-0

Lopes, J. M., Gomes, S., & Nogueira, E. (2025). Educational insights into digital entrepreneurship: The influence of personality and innovation attitudes. *Journal of Innovation and Entrepreneurship, 14*(1), Article 16. https://doi.org/10.1186/s13731-025-00475-y

Lopes, J. M., Gomes, S., & Pacheco, R. (2024). Unveiling the antecedents of sustainability-oriented entrepreneurial intentions in Angolan universities: Theory planned behavior extension proposal. *Industry and Higher Education, 38*(3), 234–245. https://doi.org/10.1177/09504222231189702

Lopes, J. M., Laurett, R., Ferreira, J. J., Silveira, P., Oliveira, J., & Farinha, L. (2023a). Modeling the predictors of students' entrepreneurial intentions: The case of a peripheral European region. *Industry and Higher Education, 37*(2), 208–221. https://doi.org/10.1177/09504222221117055

Lopes, J. M., Suchek, N., & Gomes, S. (2023b). The antecedents of sustainability-oriented entrepreneurial intentions: An exploratory study of Angolan higher education students. *Journal of Cleaner Production, 391*, Article 136236. https://doi.org/10.1016/j.jclepro.2023b.136236

Lopes, J. N. M., & Farinha, L. (2018). Measuring the performance of innovation and entrepreneurship networks. *Journal of the Knowledge Economy*, *9*(2), 402–423. https://doi.org/10.1007/s13132-017-0487-8

Lungu, A. E., Georgescu, M. R., & Juravle, D. (2024). A bibliometric analysis of digital entrepreneurship. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-024-01885-1

Madden, T. J., Ellen, P. S., & Ajzen, I. (1992). A comparison of the theory of planned behavior and the theory of reasoned action. *Personality and Social Psychology Bulletin, 18*(1), 3–9. https://doi.org/10.1177/0146167292181001

Majeed, I. K., & Hamed, S. A. (2023). Impacting digital competence on entrepreneurial alertness: An analytical research at the Central Bank of Iraq. *Journal of Economics and Administrative Sciences, 29*(137), 56–75.

Mavlutova, I., Lesinskis, K., Liogys, M., & Hermanis, J. (2020). Innovative teaching techniques for entrepreneurship education in the era of digitalisation. *WSEAS Transactions on Environment and Development*, *16*(1), 725–733.

McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the theory of planned behaviour: A meta-analysis. *Health Psychology Review*, *5*(2), 97–144. https://doi.org/10.1080/17437199.2010.521684

Mir, A. A., Hassan, S., & Khan, S. J. (2023). Understanding digital entrepreneurial intentions: A capital theory perspective. *International Journal of Emerging Markets, 18*(12), 6165–6191. https://doi.org/10.1108/IJOEM-05-2021-0687

Mutyebere, R., Twongyirwe, R., Sekajugo, J., Kabaseke, C., Kagoro-Rugunda, G., Kervyn, M., & Vranken, L. (2023). Does the farmer's social information network matter? Explaining adoption behavior for disaster risk reduction measures using the theory of planned behavior. *International Journal of Disaster Risk Reduction, 92*, Article 103721. https://doi.org/10.1016/j.ijdrr.2023.103721

Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. *Entrepreneurship Theory and Practice*, *41*(6), 1029–1055. https://doi.org/10.1111/etap.12254

Ndou, V. (2021). Social Entrepreneurship Education: A combination of knowledge exploitation and exploration processes. *Administrative Sciences, 11*(4), Article 112. https://doi.org/10.3390/admsci11040112

Ndou, V., Mele, G., & Del Vecchio, P. (2019). Entrepreneurship education in tourism: An investigation among European Universities. *Journal of Hospitality, Leisure, Sport & Tourism Education, 25*, Article 100175. https://doi.org/10.1016/j.jhlste.2018.10.003

Nguyen, P.-D., & Nguyen, H. H. (2024). Unveiling the link between digital entrepreneurship education and intention among university students in an emerging economy. *Technological Forecasting and Social Change, 203*, Article 123330. https://doi.org/10.1016/j.techfore.2024.123330

Notani, A. S. (1998). Moderators of Perceived Behavioral Control's predictiveness in the Theory of Planned Behavior: A meta-analysis. *Journal of Consumer Psychology, 7*(3), 247–271. https://doi.org/10.1207/s15327663jcp0703_02

Opoku, M. P., Cuskelly, M., Pedersen, S. J., & Rayner, C. S. (2021). Applying the theory of planned behaviour in assessments of teachers' intentions towards practicing inclusive education: A scoping review. *European Journal of Special Needs Education, 36*(4), 577–592. https://doi.org/10.1080/08856257.2020.1779979

Paul, J., Alhassan, I., Binsaif, N., & Singh, P. (2023). Digital entrepreneurship research: A systematic review. *Journal of Business Research, 156*, Article 113507. https://doi.org/10.1016/j.jbusres.2022.113507

Portugal Digital (2023). *Portuguese startup ecosystem*. Estrutura de Missão Portugal Digital. Retrieved April 24, 2024 from https://portugaldigital.gov.pt/acelerar-a-transicao-digital-em-portugal/empreendedorismo-e-startups/ecossistema-portugues-de-startups/

Purwandari, S., & Sadik, S. (2024). Entrepreneurial knowledge and digital entrepreneurial intention mediated by entrepreneurial alertness among Indonesian Polytechnic students. *Indonesian Journal of Multidisciplinary Science*, *3*(4), 313–324. https://doi.org/10.55324/ijoms.v3i4.801

Rauch, A., & Hulsink, W. (2015). Putting entrepreneurship education where the intention to act lies: An investigation into the impact of entrepreneurship education on entrepreneurial behavior. *Academy of Management Learning & Education*, *14*(2), 187–204. https://doi.org/10.5465/amle.2012.0293

Rich, A., Brandes, K., Mullan, B., & Hagger, M. S. (2015). Theory of planned behavior and adherence in chronic illness: A meta-analysis. *Journal of Behavioral Medicine*, *38*(4), 673–688. https://doi.org/10.1007/s10865-015-9644-3

Roxas, B. G., Cayoca-Panizales, R., & Jesus, R. (2008). Entrepreneurial knowledge and its effects on entrepreneurial intentions: Development of a conceptual framework. *Asia-Pacific Social Science Review, 8*(2), 61–77. https://doi.org/10.3860/apssr.v8i2.784

Sahut, J.-M., Iandoli, L., & Teulon, F. (2021). The age of digital entrepreneurship. *Small Business Economics, 56*(3), 1159–1169. https://doi.org/10.1007/s11187-019-00260-8

Sang, D., & Lin, J. (2019). How does Entrepreneurial Education Influence the Entrepreneurial Intention of College Students: The moderating and mediating effects of entrepreneurial alertness. *International Journal of Emerging Technologies in Learning (iJET), 14*(08), 139–154. https://doi.org/10.3991/ijet.v14i08.10408

Satalkina, L., & Steiner, G. (2020). Digital entrepreneurship and its role in innovation systems: A systematic literature review as a basis for future research avenues for sustainable transitions. *Sustainability, 12*(7), Article 2764. https://doi.org/10.3390/su12072764

Schlaegel, C., & Koenig, M. (2014). Determinants of entrepreneurial intent: A meta–analytic test and integration of competing models. *Entrepreneurship Theory and Practice, 38*(2), 291–332. https://doi.org/10.1111/etap.12087

Scuotto, V., & Morellato, M. (2013). Entrepreneurial knowledge and digital competence: Keys for a success of student entrepreneurship. *Journal of the Knowledge Economy*, *4*(3), 293–303. https://doi.org/10.1007/s13132-013-0155-6

Secundo, G., Ndou, V., Del Vecchio, P., & De Pascale, G. (2019). Knowledge management in entrepreneurial universities. *Management Decision, 57*(12), 3226–3257. https://doi.org/10.1108/MD-11-2018-1266

Sharma, L. (2019). A systematic review of the concept of entrepreneurial alertness. *Journal of Entrepreneurship in Emerging Economies*, *11*(2), 217–233. https://doi.org/10.1108/JEEE-05-2018-0049

Shen, K. N., Lindsay, V., & Xu, Y. (2018). Digital entrepreneurship. *Information Systems Journal, 28*(6), 1125–1128. https://doi.org/10.1111/isj.12219

Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J. H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: Guidelines for using PLSpredict. *European Journal of Marketing*, *53*(11), 2322–2347. https://doi.org/10.1108/ejm-02-2019-0189

Si, H., Shi, J.-g, Tang, D., Wen, S., Miao, W., & Duan, K. (2019). Application of the theory of planned behavior in environmental science: A comprehensive bibliometric analysis. *International Journal of Environmental Research and Public Health, 16*(15), Article 2788. https://doi.org/10.3390/ijerph16152788

Singh, R., Kumar, V., Singh, S., Dwivedi, A., & Kumar, S. (2024). Measuring the impact of digital entrepreneurship training on entrepreneurial intention: The mediating role of entrepreneurial competencies. *Journal of Work-Applied Management, 16*(1), 142–163. https://doi.org/10.1108/JWAM-11-2022-0076

Sitaridis, I., & Kitsios, F. (2024). Digital entrepreneurship and entrepreneurship education: A review of the literature. *International Journal of Entrepreneurial Behavior & Research*, *30*(2/3), 277–304. https://doi.org/10.1108/IJEBR-01-2023-0053

Sobaih, A. E. E., & Elshaer, I. A. (2022). Personal traits and digital entrepreneurship: A mediation model using SmartPLS data analysis. *Mathematics, 10*(21), Article 3926. https://doi.org/10.3390/math10213926

Souitaris, V., Zerbinati, S., & Al-Laham, A. (2007). Do entrepreneurship programmes raise entrepreneurial intention of science and engineering students? The effect of learning, inspiration and resources. *Journal of Business Venturing, 22*(4), 566–591. https://doi.org/10.1016/j.jbusvent.2006.05.002

Srinivasan, A., & Venkatraman, N. (2018). Entrepreneurship in digital platforms: A network-centric view. *Strategic Entrepreneurship Journal*, *12*(1), 54–71. https://doi.org/10.1002/sej.1272

Stanić, M. (2020). Decoding the entrepreneurial capacity: The case of entrepreneurial alertness. *Zagreb International Review of Economics & Business*, *23*(SCI), 1–12.

Startup Portugal (2023). *Startup & Entrepreneurial Ecosystem Report 2023*. Startup Portugal. Retrieved April 24, 2024 from https://startupportugal.com/startup-entrepreneurial-ecosystem-report-2023/

Steininger, D. M., Kathryn Brohman, M., & Block, J. H. (2022). Digital entrepreneurship: What is New if Anything? *Business & Information Systems Engineering, 64*(1), 1–14. https://doi.org/10.1007/s12599-021-00741-9

Sussman, R., & Gifford, R. (2019). Causality in the theory of planned behavior. *Personality and Social Psychology Bulletin*, *45*(6), 920–933. https://doi.org/10.1177/0146167218801363

Tang, J., Kacmar, K. M., & Busenitz, L. (2012). Entrepreneurial alertness in the pursuit of new opportunities. *Journal of Business Venturing, 27*(1), 77–94. https://doi.org/10.1016/j.jbusvent.2010.07.001

Teo, T., Zhou, M., & Noyes, J. (2016). Teachers and technology: Development of an extended theory of planned behavior. *Educational Technology Research and Development*, *64*(6), 1033–1052. https://doi.org/10.1007/s11423-016-9446-5

Tóth-Pajor, Á., Bedő, Z., & Csapi, V. (2023). Digitalization in entrepreneurship education and its effect on entrepreneurial capacity building. *Cogent Business & Management, 10*(2), Article 2210891. https://doi.org/10.1080/23311975.2023.2210891

Upadhyay, N., Upadhyay, S., Al-Debei, M. M., Baabdullah, A. M., & Dwivedi, Y. K. (2023). The influence of digital entrepreneurship and entrepreneurial orientation on intention of family businesses to adopt artificial intelligence: Examining the mediating role of business innovativeness. *International Journal of Entrepreneurial Behavior & Research, 29*(1), 80–115. https://doi.org/10.1108/IJEBR-02-2022-0154

Vu, T. H., Do, A. D., Ha, D. L., Hoang, D. T., Van Le, T. A., & Le, T. T. H. (2024). Antecedents of digital entrepreneurial intention among engineering students. *International Journal of Information Management Data Insights, 4*(1), 100233. https://doi.org/10.1016/j.jjimei.2024.100233

Wang, Q., Sun, Z., & Wu, C. (2021). The impact of university innovation and entrepreneurship education on entrepreneurial intention from the perspective of educational psychology. *Frontiers in Psychology*, *12*, 1–13. https://doi.org/10.3389/fpsyg.2021.745976

Westhead, P., & Solesvik, M. Z. (2016). Entrepreneurship education and entrepreneurial intention: Do female students benefit? *International Small Business Journal*, *34*(8), 979–1003. https://doi.org/10.1177/0266242615612534

Wibowo, A., & Narmaditya, B. S. (2022). Predicting students' digital entrepreneurial intention: The mediating role of knowledge and inspiration. *Dinamika Pendidikan*, *17*(1), 25–36. https://doi.org/10.15294/dp.v17i1.36161

Wibowo, A., Narmaditya, B. S., Saptono, A., Effendi, M. S., Mukhtar, S., & Mohd Shafiai, M. H. (2023). Does digital entrepreneurship education matter for students' digital entrepreneurial intentions? The mediating role of entrepreneurial alertness. *Cogent Education, 10*(1), Article 2221164. https://doi.org/10.1080/2331186X.2023.2221164

Wurthmann, K. (2014). Business students' attitudes toward innovation and intentions to start their own businesses. *International Entrepreneurship and Management Journal*, *10*(4), 691–711. https://doi.org/10.1007/s11365-013-0249-4

Yadav, R., & Pathak, G. S. (2016). Young consumers' intention towards buying green products in a developing nation: Extending the theory of planned behavior. *Journal of Cleaner Production, 135*, 732–739. https://doi.org/10.1016/j.jclepro.2016.06.120

Yaghoubi F. A., Karimi, S., & Motaghed, M. (2017). The role of entrepreneurial knowledge as a competence in shaping Iranian students' career intentions to start a new digital business. *European Journal of Training and Development, 41*(1), 83–100. https://doi.org/10.1108/EJTD-07-2016-0054

Yaghoubi Farani, A., Karimi, S., & Motaghed, M. (2017). The role of entrepreneurial knowledge as a competence in shaping Iranian students' career intentions to start a new digital business. *European Journal of Training and Development*, *41*(1), 83–100. https://doi.org/10.1108/EJTD-07-2016-0054

Yao, M., Ye, D., Yang, G., Shi, H., & Zheng, X. (2021). Are entrepreneurial capabilities and prior knowledge the silver bullet for the generation of new digital venture ideas in a digital context? *Journal of Global Information Management, 29*(6), 1–17. https://doi.org/10.4018/JGIM.20211101.oa12

Zainal, N. T. A., & Yong, K. (2020). Examining the digital entrepreneurship education effectiveness on soft skills among undergraduates. *MANU Jurnal Pusat Penataran Ilmu Dan Bahasa*, *31*(1), 139–151. https://doi.org/10.51200/manu.v31i1.2112

Zhao, D., Tian, F., Sun, X., & Zhang, D. (2021a). The effects of entrepreneurship on the enterprises' sustainable innovation capability in the digital era: The role of organizational commitment, person–organization value fit, and perceived organizational support. *Sustainability, 13*(11), Article 6156.

Zhao, F., Wallis, J., & Singh, M. (2015). E-government development and the digital economy: A reciprocal relationship. *Internet Research*, *25*(5), 734–766. https://doi.org/10.1108/IntR-02-2014-0055

Zhao, W., Yang, T., Hughes, K. D., & Li, Y. (2021b). Entrepreneurial alertness and business model innovation: The role of entrepreneurial learning and risk perception. *International Entrepreneurship and Management Journal, 17*(2), 839–864. https://doi.org/10.1007/s11365-020-00637-2

Zhao, Y. (2021). Examining digital entrepreneurship: The goal of optimization of transformation path normal education in China. *Frontiers in Psychology*, *12*, 1–12. https://doi.org/10.3389/fpsyg.2021.766498

Zheng, K., Kumar, J., Kunasekaran, P., & Valeri, M. (2024). Role of smart technology use behaviour in enhancing tourist revisit intention: The theory of planned behaviour perspective. *European Journal of Innovation Management, 27*(3), 872–893. https://doi.org/10.1108/EJIM-03-2022-0122

Zulwisli, A., Muhammad, A., & Andhika, H. (2024). The effect of theory of planned behavior (TBP) and creativity-based industry perception on digital entrepreneurship: An innovativeness as mediator. *Paperasia, 40*(3b), 96–105. https://doi.org/10.59953/paperasia.v40i3b.100

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