Exploring Digital Source of Information on Opportunity Recognition for Future Entrepreneurs: Self-Efficacy as the Mediator

Maria Grace Herlina
Management Department, BINUS Business School Undergraduate Program
Bina Nusantara University
Jl. K H. Syahdan No. 9 Kemanggisan – Palmerah Jakarta 11480, Indonesia
E-mail address: maria.herlina@binus.ac.id
ORCID: https://orcid.org/0000-0001-5119-7761

Eren Ozgen
Business Administration Program, Florida State University Panama City
4750 Collegiate Dr, Panama City, Florida 32405-1099, United States of America
E-mail address: eozgen@pc.fsu.edu
ORCID: https://orcid.org/0009-0004-9210-2123

Yunita Wijaya Handranata
Business Creation Program, BINUS Business School Undergraduate Program
Bina Nusantara University
Jl. K H. Syahdan No. 9 Kemanggisan – Palmerah Jakarta 11480, Indonesia
E-mail address: yunita.wijaya@binus.edu
ORCID: https://orcid.org/0000-0002-4777-0673

Banu Rinaldi
Business Creation Program, BINUS Business School Undergraduate Program
Bina Nusantara University
Jl. K H. Syahdan No. 9 Kemanggisan – Palmerah Jakarta 11480, Indonesia
E-mail address: banu.rinaldi@binus.ac.id
ORCID: https://orcid.org/0000-0003-2590-1262

ABSTRACT

Aim. This article examines how digital platforms, applications, and artifacts affect opportunity recognition in entrepreneurship education, focusing on self-efficacy among Indonesian undergraduates. The aim is to understand how these digital resources help students recognise entrepreneurial opportunities and develop entrepreneurial competencies.

Methods. A cross-sectional survey of 202 undergraduates in Greater Jakarta, Indonesia, assessed their use of digital platforms, applications, and artifacts. Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to examine the relationships among digital sources, self-efficacy, and opportunity recognition.

Results. The study finds that digital platforms and applications help students identify entrepreneurial opportunities, with self-efficacy partially mediating the effects of digital artifacts. Digital artifacts increased self-efficacy but did not directly influence opportunity recognition. The findings emphasise the need for interactive digital tools in entrepreneurship education and highlight the critical role of self-efficacy in the learning process.

Conclusion. Digital platforms and applications significantly contribute to students' opportunity recognition, while digital artifacts support the development of self-efficacy. Enhancing self-efficacy is essential for optimising digital learning outcomes in entrepreneurship education.

Research restrictions. The study is limited to undergraduate students in Greater Jakarta, which may limit the generalisability of the findings. Future research should explore broader demographic and cross-cultural contexts.

Keywords: digital artifacts, digital platforms, digital applications, opportunity recognition, entrepreneurship education

Introduction

Entrepreneurship education is increasingly recognised for its role in economic development and global competitiveness (Mohamed & Sheikh Ali, 2021). As digital technologies reshape industries, their integration into entrepreneurship education is accelerating. Yet, the specific impact of digital information sources on opportunity recognition remains underexplored. Opportunity recognition — central to entrepreneurial success — requires innovation and awareness, which digital tools may help enhance. This study investigates how digital platforms, applications, and artifacts influence opportunity recognition among student entrepreneurs, with self-efficacy as a mediating factor. The findings aim to enrich entrepreneurship education in today's digital landscape.

Opportunity Recognition

Opportunity recognition is a critical step in the entrepreneurial process (Baron & Ensley, 2006; Grégoire et al., 2010; Mary George et al., 2016; Ozgen et al., 2007; Ozgen & Baron, 2007). Kirzner's theory of incremental innovation highlights information asymmetry and entrepreneurial alertness as key drivers in identifying profitable opportunities (Kirzner, 1973, 1979). Alertness — shaped by access to relevant knowledge — enables individuals to recognise and act on emerging prospects.

While earlier studies emphasize various sources of information (e.g., social and job-related), limited research addresses digital information sources in the context of opportunity recognition within entrepreneurship education (Nambisan, 2017; Oberländer et al., 2021; Steininger, 2019; Ali et al., 2017; Chen et al., 2021). Recent findings underscore the role of social media and MOOCs in fostering entrepreneurial alertness (Fellnhofer, 2022; Secundo et al., 2020; Vorbach et al., 2019). However, the influence of digital sources on opportunity recognition — particularly through the mediating role of self-efficacy — remains underexplored.

This study addresses that gap by examining how digital platforms, applications, and artifacts affect opportunity recognition and the extent to which self-efficacy mediates this relationship.

Opportunity Recognition in Entrepreneurship Education and Digital Technologies

Entrepreneurship education aims to develop an innovative and opportunity-seeking mindset (Cui et al., 2021; Martínez-Gregorio et al., 2021; Ndou et al., 2018; Ratten & Jones, 2021; Rosendahl Huber et al., 2020). It enhances students' creativity, problem-solving, and entrepreneurial skills through transferable competencies and knowledge (Costa et al., 2018; Greene & Saridakis, 2008; Ilonen & Heinonen, 2018; Nambisan, 2017; Tantawy et al., 2021; Yao et al., 2021), and encourages networking and opportunity-driven thinking (Bonesso et al., 2018; Byun et al., 2018; Handayati et al., 2020; Ozgen et al., 2007; Ozgen & Minsky, 2013; Ratten & Jones, 2021).

Modern entrepreneurship education embraces interactive, stakeholder-based learning (Galvão et al., 2020; Lu & Jover, 2019; Ratten & Jones, 2021; Ratten & Usmanij, 2021). Social networks provide essential information and resources, boosting opportunity recognition through collaboration and knowledge exchange (Arenius & Clercq, 2005; Ozgen & Baron, 2007; Perry-Smith, 2006; Santarelli & Tran, 2013; Sexton & Bowman-Upton, 1991; Singh, 2000).

Digital technologies further support this process by enhancing access to knowledge, resources, and entrepreneurial ecosystems (Abernathy & Clark, 1985; Cheng et al., 2022; Horta et al., 2016; Miller et al., 2018; Ndou et al., 2018; Secundo et al., 2020; Tarabasz

et al., 2018; von Briel et al., 2018). While digital tools are known to enhance opportunity recognition (Adner, 2006; Chen et al., 2021; Iansiti & Levien, 2004; Parker et al., 2017), their role — especially in shaping self-efficacy — remains underexplored.

Research Questions

- To what extent do digital sources of information (platforms, applications, artifacts) influence opportunity recognition?
- To what extent does self-efficacy mediate this relationship, enhancing student entrepreneurs' alertness?

Digital Sources of Opportunity-Relevant Information: Digital platforms

Digital platforms, including social media (e.g., Facebook, LinkedIn, Twitter) and app stores, play a vital role in entrepreneurship by promoting mindset development, trend awareness, and business management (Deng, 2021; Heeks et al., 2021; Fan et al., 2021; Żur, 2018). MOOCs also support entrepreneurship education by spreading entrepreneurial culture and fostering teamwork (Al-Atabi & Deboer, 2014; Chen et al., 2021; Secundo et al., 2020; Vinogradova et al., 2019; Vorbach et al., 2019; Żur, 2018).

These platforms enhance entrepreneurial alertness by enabling connectivity, collaboration, creativity, and access to real-time information (Fellnhofer, 2022; Lomberg et al., 2017; Secundo et al., 2020). Social media, especially Facebook, has been shown to outperform other tools in facilitating interaction between students and entrepreneurs (Ali et al., 2017; Secundo et al., 2020; Chen et al., 2021). In Italy, social media was found to be the most widely adopted digital tool among entrepreneurship students (Secundo et al., 2020).

Focusing on social media and online communities, this study explores how digital platform engagement relates to opportunity recognition.

Hypothesis 1: Entrepreneurs who extensively use digital platforms are more likely to identify and capitalise on new venture opportunities.

Digital Sources of Opportunity-Relevant Information: Digital Applications

Digital applications — such as simulations, games, and virtual reality — are widely used in entrepreneurship education to boost engagement, motivation, and performance (Mayer et al., 2014; Subhash & Cudney, 2018; Chen et al., 2021). Gamification creates immersive, risk-free environments where students explore real-world business scenarios, enhancing their learning and business practices (Fox et al., 2018; Kauppinen & Iftikhar Choudhary, 2021).

Compared to MOOCs and social media, gaming has shown higher effectiveness in fostering entrepreneurial mindset, motivation, and user satisfaction (Chen et al., 2021). Virtual reality further enhances immersion, enabling deeper information retention and realistic interaction (Orel, 2020; Zhang, 2021).

These tools help students test ideas, simulate industries, and develop opportunity recognition skills.

Hypothesis 2: Entrepreneurs who extensively use digital applications are more likely to identify and capitalise on opportunities for new ventures.

Digital Sources of Opportunity-Relevant Information: Digital artifacts

Digital artifacts — such as audio, video files, and digital images — are media components that enhance user functionality and learning (Kallinikos et al., 2013; Marzano & Miranda, 2021; Nambisan, 2017; Sigfusson & Chetty, 2013; Wraae et al., 2021). Podcasts and video content have been shown to improve entrepreneurial competencies (Diaz Vidal et al., 2021; Thompson & Illes, 2021; Wraae et al., 2021), with video clips proven effective for entrepreneurial learning in Denmark and Finland (Wraae et al., 2021).

However, their limited real-time interaction may restrict dynamic engagement, making them less effective for recognising current opportunities compared to platforms and applications. Artifacts often reflect past ventures and lack the context or immediacy needed for identifying emerging trends.

Hypothesis 3: The influence of reliance on digital platforms and applications on entrepreneurs' knowledge of emerging business opportunities will surpass the impact of dependence on digital artifacts.

Self-Efficacy as the Mediator

Self-efficacy refers to an individual's belief in their ability to complete tasks successfully (Bandura, 1997), influencing their likelihood of recognising and acting on opportunities (Krueger, 1989). High self-efficacy leads to greater risk-taking and opportunity awareness. Research consistently highlights its importance in opportunity recognition (Camelo-Ordaz et al., 2020; Sobakinova et al., 2019; Tumasjan & Braun, 2012). For example, innovation support enhances creative self-efficacy (Liao et al., 2022), and self-efficacy plays a key role in entrepreneurial intentions (Hassan, 2020).

Digital technologies can foster self-efficacy. Virtual reality environments help students practice pitches and interact socially, boosting confidence (Orel, 2020). Digital literacy supports self-efficacy and improves online learning behavior (Prior et al., 2016), while enhanced ICT use and network interactions raise internet self-efficacy (Wu et al., 2023).

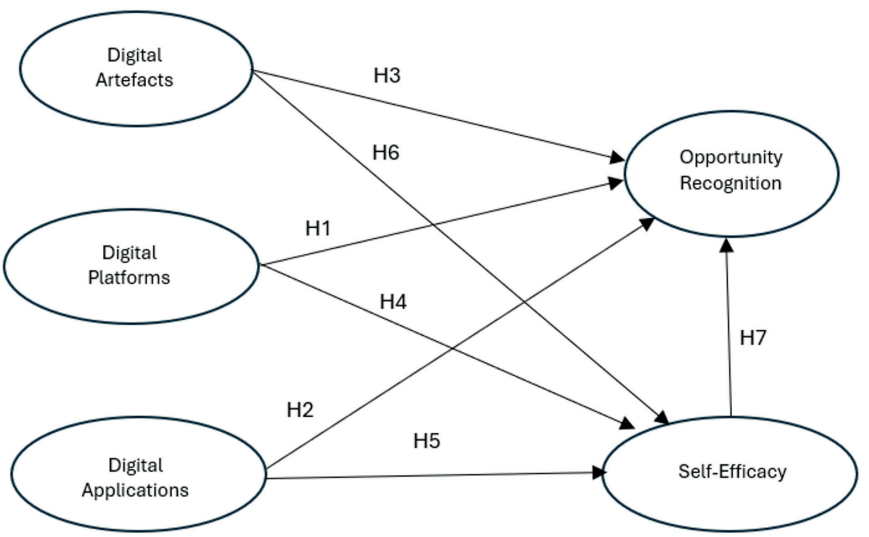
Thus, digital tools facilitate collaboration, access to information, and skill development, encouraging individuals to recognise and pursue entrepreneurial opportunities more effectively.

Hypotheses

- **H4**: The impact of using digital applications on opportunity recognition will be partially mediated by self-efficacy.
- **H5**: The impact of using digital platforms on opportunity recognition will be partially mediated by self-efficacy.
- **H6**: The impact of using digital artifacts on opportunity recognition will be partially mediated by self-efficacy.
- **H7**: A higher level of self-efficacy among entrepreneurs relates to an increased likelihood of identifying prospects for new ventures.

We performed a survey to 202 undergraduate students in Indonesia to evaluate these hypotheses. The poll aimed to gauge their reliance on various digital information sources and their awareness of emerging opportunities. Additional items measured their self-efficacy.

Figure 1
Research Framework



Source. Own research.

Method

Research Design and Approaches

This study used a cross-sectional survey and quantitative approach with Partial Least Squares Structural Equation Modelling (PLS-SEM) to test the hypotheses. It examines how digital information sources influence opportunity recognition, mediated by self-efficacy, among Indonesian university students. The research was conducted in Greater Jakarta, selected for its role as Indonesia's economic hub.

Sample

The participants were undergraduate students in Jakarta, Indonesia, with entrepreneurial experience or intentions. Data collection spanned 67 days (13 December 2022–18 February 2023). From 224 initial responses, 22 outliers were removed using Box Plot analysis, resulting in a final sample of 202 students. Outliers were defined as values beyond 1.5× the interquartile range, and extreme values as those beyond 3×.

Participants came from diverse majors: Business and Entrepreneurship (99), Economics and Management (34), It (17), Computer Science (13), Science and Technology (10), Marketing and Communications, Design and Art (2), International Business Management (1), and International Relations (1) (see Table 1). This diversity reflects the multidisciplinary nature of entrepreneurship education, supporting broader applicability of the findings.

Table 1
Sample Characteristics

Respondent Characteristic		Total	
		Number	%
Gender	Male	112	62.22
	Female	68	37.78
Age (y.o)	16-20	133	73.89
	21-25	46	25.56
	> 25	1	0.56
Major of Study	Business and Entrepreneurship	99	55.00
	Marketing Communications	3	1.67
	Computer Science	13	7.22
	Design & Art	2	1.11
	Economics & Management	34	18.89
	Information Technology	17	9.44
	International Business Management	1	0.56
	International Relations	1	0.56

Respondent Characteristic		Total	
		Number	%
	Science & Technology	10	5.56
Degree of Study	D1-4 (Diploma)	4	2.22
	Undergraduate	176	97.78
GPA	< 2.00	2	1.11
	2.00 – 2.99	21	11.67
	3.00 – 3.50	69	38.33
	> 3.50	88	48.89
Ethnicity	Bali – Nusa Tenggara	1	0.56
	Betawi	5	2.78
	Borneo	12	6.67
	Chinese	85	47.22
	Chinese – Sumatra	1	0.56
	Java	53	29.44
	Java – Sumatra	1	0.56
	Sulawesi	3	1.67
	Sumatra	16	8.89
	Sunda	1	0.56
	Sumatra – Sunda	1	0.56
	Other	1	0.56
Religion	Buddha	36	20.00
	Hindu	2	1.11
	Islam	49	27.22
	Christian	59	32.78
	Catholic	33	18.33
	Kong Hu Cu	1	0.56

Source. Primary data collected by the authors.

Measurement

Table 2
Measurement

Construct	Code		Measurement Item
Digital Artifacts	DAR1	:	Getting information from digital documents and images helped me recognise opportunities.
(the authors developed the scale)	DAR2	:	Getting information from video and audio files helped me recognise opportunities.
	DAR3	:	Getting information from virtual presentations helped me recognise opportunities.
Digital Platforms (the authors developed the scale)	DP1	:	My discussions in online communities, social media, and social networks helped me recognise business opportunities.

Construct	Code		Measurement Item
	DP2	:	Getting information from my social and professional contacts in social media and online communities helped me recognise opportunities.
	DP3	:	I think social media and online communities are helpful in recognising opportunities.
Digital Application	DAP1	:	Using simulations, games, and or virtual reality in a similar industry helped me recognise opportunities.
(the authors developed the scale)	DAP2	:	Using simulations, games, and or virtual reality in another industry helped me recognise opportunities.
	DAP3	:	I think using simulations, games, and or virtual reality is helpful in recognising opportunities.
Self Efficacy	SE1	:	I am strong enough to overcome life's struggles
(Maurer and Pierce, 1998)	SE2	:	Basically, I am a strong person.
	SE3	:	I can handle the situations that life brings.
	SE4	:	I usually feel that I am a successful person.
	SE5	:	I often feel that I can do everything well.
	SE6	:	I feel competent to deal effectively with the real world.
	SE7	:	I often feel like a success.
	SE8	:	I usually feel I can handle the typical problems that come up in life
Opportunity Recognition (Singh et al., 1999)	OR1	:	I can recognise new business opportunities in industries where I have no personal experience.
	OR2	:	The new business opportunities I have recognised over the years have been mostly unrelated to each other.
	OR3	:	Recognising good opportunities usually requires an interest in a specific industry or marketplace.
	OR4	:	While going about routine day-to-day activities, I see potential new business ideas all around me.
	OR5	:	I have a special alertness or sensitivity toward new business opportunities.
	OR6	:	Seeing potential new business opportunities does not come very naturally to me.

Source. Own research; Maurer and Pierce (1998); Singh et al. (1999).

Based on a literature review, a structured survey was developed to measure the variables. Custom items were created for the independent variables — digital platforms, applications, and artifacts — to ensure validity and comprehensive assessment. Standardised scoring was used to evaluate how digital information access influences opportunity recognition (see Table 2 for scales).

Operationalisation of Variables:

- *Opportunity Recognition*: Measured with six items from Singh et al. (1999), assessing vigilance and ability to identify new opportunities.
- *Self-Efficacy*: Assessed using an eight-item scale from Maurer & Pierce (1998), previously validated in related studies.
- *Digital Platforms*: Items measured reliance on social media and online communities for opportunity-related information. Terms like "social media" and "social networks" were used interchangeably to reflect current usage.
- *Digital Applications*: Measured through three items related to simulations, games, and virtual reality in supporting opportunity identification.
- *Digital Artifacts*: Assessed via three items examining the use of digital files (e.g., documents, videos, audio) as sources of opportunity-related information.

Data Analysis

Survey data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) with a formative research model to assess hierarchical constructs and their interrelations (Ghozali, 2021; Hair et al., 2014; Sarstedt et al., 2014). The analysis was conducted in SMARTPLS 3.2.9, covering the measurement model, structural model, and hypothesis testing.

Results

Scale Refinement

This study used five measurement criteria — loading factor, Cronbach's alpha, composite reliability, AVE, and cross-loadings — to ensure validity and reliability. Indicators with loading factors ≥0.5 and composite reliability >0.70 are considered acceptable (Hair Jr. et al., 2009; Hair et al., 2014), while a Cronbach's alpha >0.6 is sufficient for exploratory research (Garson, 2016).

Two indicators (OR3 and OR6) were removed due to low reliability. Remaining indicators met criteria, with loading factors ranging from 0.598 (OR2) to 0.921 (DAP2). Cronbach's alpha and composite reliability also exceeded thresholds, with the lowest values for opportunity recognition at 0.698 and 0.815 (see Table 3).

Table 3
Measurement Model Analysis

Latent Variable	Indicator	Loading Factor (>0.5)	Remark	Cronbach's Alpha (³0.6)	Composite Reliability (³0.7)	AVE (³0.5)	Remark
Digital Artifacts	DAR1	0.874	Valid	0.791	0.877	0.704	Reliable
	DAR2	0.807					
	DAR3	0.835					
Digital Platforms	DP1	0.815		0.795	0.880	0.709	Reliable
	DP2	0.902					
	DP3	0.806					
Digital Applications	DAP1	0.913		0.896	0.935	0.828	Reliable
	DAP2	0.921					
	DAP3	0.895					
Self Efficacy	SE1	0.723		0.921	0.936	0.645	Reliable
	SE2	0.804					
	SE3	0.812					
	SE4	0.783					
	SE5	0.820					
	SE6	0.827					
	SE7	0.800					
	SE8	0.851					
Opportunity Recognition	OR1	0.734		0.698	0.815	0.526	Reliable
	OR2	0.598					
	OR4	0.761					
	OR5	0.793					

Source. Primary data processed by the authors using SMARTPLS 3.2.9 (2023).

The validity test was assessed using Average Variance Extracted (AVE), with a threshold value above 0.5 and the loading factor. Table 3 shows that all AVE for all latent variables are above 0.5, with the highest value of 0.828 for digital tools and the lowest value of 0.526 for opportunity recognition. Moreover, for the cross-loading test, Table 4 shows that the correlations between indicators and their respective latent variables are higher than correlations with other latent variables. Thus, it can be concluded that all latent variables and their indicators are valid and reliable.

Table 4
Cross Loadings

Latent Variable	Digital Artifacts	Digital Platforms	Digital Tools	Self Efficacy	Opportunity Recognition	Remark
DAR1	*0.874*	0.524	0.469	0.423	0.341	Valid
DAR2	*0.807*	0.528	0.417	0.310	0.273	Valid

Latent Variable	Digital Artifacts	Digital Platforms	Digital Tools	Self Efficacy	Opportunity Recognition	Remark
DAR3	*0.835*	0.555	0.437	0.387	0.378	Valid
DP1	0.475	*0.815*	0.403	0.363	0.350	Valid
DP2	0.597	*0.902*	0.397	0.362	0.381	Valid
DP3	0.542	*0.806*	0.414	0.252	0.301	Valid
DAP1	0.508	0.414	*0.913*	0.290	0.351	Valid
DAP2	0.473	0.446	*0.921*	0.311	0.382	Valid
DAP3	0.457	0.443	*0.895*	0.328	0.339	Valid
SE1	0.354	0.344	0.313	*0.723*	0.350	Valid
SE2	0.355	0.328	0.298	*0.804*	0.337	Valid
SE3	0.433	0.368	0.274	*0.812*	0.352	Valid
SE4	0.288	0.269	0.185	*0.783*	0.366	Valid
SE5	0.355	0.314	0.296	*0.820*	0.420	Valid
SE6	0.396	0.245	0.240	*0.827*	0.383	Valid
SE7	0.294	0.289	0.305	*0.800*	0.418	Valid
SE8	0.405	0.362	0.268	*0.851*	0.372	Valid
OR1	0.291	0.300	0.286	0.299	*0.734*	Valid
OR2	0.187	0.177	0.251	0.284	*0.598*	Valid
OR4	0.412	0.412	0.267	0.363	*0.761*	Valid
OR5	0.241	0.276	0.337	0.396	*0.793*	Valid

Source. Primary data processed by the authors using SMARTPLS 3.2.9 (2023).

Principal Analyses

Table 5
Structural Model Assessment

Relationship	Path	STDEV	t-statistic	p-value	Conclusion
DP ® OR	0.166	0.079	2.106	0.036	H1 Supported
DAR ® OR	0.176	0.066	2.650	0.008	H2 Supported
DAP ® OR	0.058	0.081	0.725	0.469	H3 is supported (as DAP ≠ OR)
DP ® SE	0.152	0.082	1.849	0.065	H4 Not Supported
DAP ® SE	0.113	0.070	1.616	0.107	H5 Not Supported
DAR ® SE	0.294	0.085	3.471	0.001	H6 Supported
SE ® OR	0.315	0.063	4.978	0.000	H7 Supported

Note. DAR: Digital Artifacts, DP: Digital Platforms, DAP: Digital Applications, OR: Opportunity Recognition, SE: Self Efficacy, OR: Opportunity Recognition.

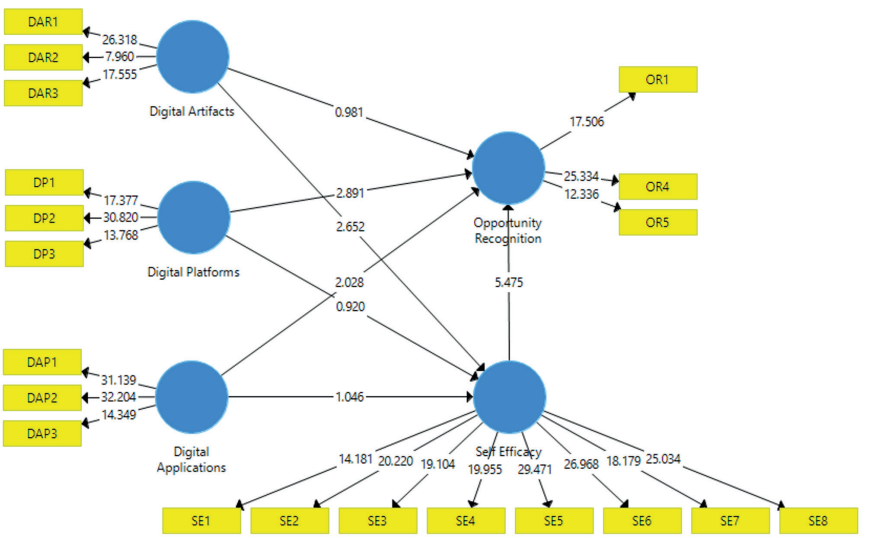
Source. Primary data processed by the authors using SMARTPLS 3.2.9 (2023).

Direct Effects of Variables

As illustrated in Table 5, an analysis of the standardised parameter estimates revealed that, in alignment with Hypotheses 1, 2, 6, and 7, there were direct associations between digital applications, digital platforms, self-efficacy, and alertness to business opportunities (with t-statistics greater than 1.96 and $p < .05$ in all cases).

Figure 2

Path Analysis of Structural Model (Bootstrapping)



Source. Primary data processed by the authors using SMARTPLS 3.2.9 (2023).

Hypothesis 3 predicted that digital platforms and applications would have a stronger impact on opportunity recognition than digital artifacts. The results confirmed this: platforms and applications showed significant effects ($t > 1.96$; $p < .05$), while digital artifacts did not ($t < 1.96$; $p > .05$).

Mediated Effects

Hypothesis 7 was supported—self-efficacy significantly influenced opportunity recognition ($t > 1.96$; $p < .01$). Among the digital sources, only digital artifacts had a significant effect on self-efficacy ($t > 1.96$; $p < .01$), indicating that only this pathway was mediated.

Discussion

This study reinforces the role of digital technologies in entrepreneurship education and their impact on opportunity recognition. Our findings align with prior

research showing that digital platforms help entrepreneurs identify opportunities (Chen et al., 2021; Parker et al., 2016; Adner, 2006; Iansiti & Levien, 2004), consistent with work by Vorbach et al. (2019), Secundo et al. (2020), and Fellnhofer (2021). Indonesian Gen Z students, the most active social media users (Alvara Research Centre, 2022), often seek opportunities via YouTube, Instagram, and TikTok.

Digital applications — such as simulations, games, and virtual reality — also support opportunity recognition by fostering creative thinking and engagement (Fox et al., 2018; Kauppinen & Choudhary, 2021). These tools are especially effective for digital-native students, highlighting the value of interactive learning in entrepreneurship education.

Integrating digital platforms, games, and multimedia into the classroom fosters real-time decision-making, collaboration, and problem-solving — key to developing opportunity recognition. Such approaches also prepare students for a digital workforce and nurture innovation and adaptability.

While digital artifacts (e.g., audio, video, images) do not directly influence opportunity recognition, they significantly enhance self-efficacy, which in turn affects opportunity awareness (Kallinikos et al., 2013; Diaz Vidal et al., 2021; Thompson & Illes, 2021; Wraae et al., 2021). These artifacts inspire and inform, particularly for students with high self-efficacy.

However, the effect of digital platforms and applications is not mediated by self-efficacy. Instead, self-efficacy shapes how students engage with digital tools. This implies that improving self-efficacy is key — especially for students with low confidence — enabling them to benefit more from digital learning environments.

Educators should enhance students' self-efficacy while leveraging digital technologies to strengthen Gen Z's opportunity recognition in entrepreneurship.

Practical Implications

This study supports the integration of digital technology in entrepreneurship education to enhance students' opportunity recognition. For educators and policymakers, key strategies include incorporating digital platforms, simulations, and gamified modules to build decision-making and entrepreneurial skills (Chen et al., 2021; Fox et al., 2018; Kauppinen & Choudhary, 2021).

Custom digital platforms featuring case studies, interactive tasks, and peer collaboration tools can deepen engagement. Multimedia tools — such as videos, audio, and images — can showcase real ventures, trends, and industry insights, while podcasts and webinars with entrepreneurs provide valuable real-world perspectives (Diaz Vidal et al., 2021; Thompson & Illes, 2021; Wraae et al., 2021).

Fostering self-efficacy is also crucial. Reflection tools, mentoring, and networking with experts can help students build confidence, resilience, and readiness for entrepreneurial success (Bandura, 1997; Liao et al., 2022; Hassan, 2020).

Limitations

This study has several limitations. First, the sample was limited to 180 undergraduate students from one Indonesian university, which may affect generalisability. While students came from diverse academic backgrounds, results may reflect institutional-specific factors.

Second, the study was conducted in Indonesia, where cultural and regional contexts may influence the relationship between digital engagement, opportunity recognition, and self-efficacy. Findings may not fully apply to other settings.

Lastly, reliance on self-reported data may introduce bias due to subjective interpretation and recall errors.

Conclusion

This study has demonstrated the significant role of digital sources of information in fostering opportunity recognition within entrepreneurship education. The findings indicate that digital platforms and applications directly contribute to opportunity recognition, with self-efficacy, mediating the effects of these digital artifacts. These insights underscore the importance of integrating digital tools, such as social media, simulations, and virtual reality, into entrepreneurship curricula to enhance students' ability to identify new business opportunities. The study also highlights the need for fostering self-efficacy, as it plays a crucial role in the effective use of digital resources. While the research is limited by its sample size and regional scope, it provides a valuable foundation for future studies that could explore a broader, more diverse range of participants across different cultural contexts. Ultimately, the study contributes to the evolving field of entrepreneurship education by emphasising the interaction between digital technologies and self-efficacy, offering practical recommendations for educators and policymakers aiming to improve opportunity recognition in future entrepreneurs.

Future Study

Our study was intentionally designed to capture real-world experiences and behaviour within the context of entrepreneurship education and the use of digital information sources. It serves as a foundational exploration of the intricate relationship between digital platforms and opportunity recognition in this field, providing valuable insights into practical dynamics.

While controlled interventions and pre- and post-test scenarios have their merits for studying causality, our study takes a distinct approach by offering a holistic view of the natural practices within entrepreneurship education. Future research

can build upon our work by utilising diverse methodologies to gain a comprehensive understanding of this multifaceted field.

We recommend expanding the study to include multiple countries representing diverse cultural and social contexts. By including participants from different countries, research findings can be compared across various contexts, increasing their generalisability.

AUTHORS' CONTRIBUTORSHIP

EO and MGH were responsible for conceptualization, methodology, software development, manuscript drafting, and supervision. BR and MGH contributed to data curation, investigation, and preparation of the literature review, as well as writing, proofreading, and editing. YWH conducted the formal analysis and contributed to the writing of the analytical section and review of the manuscript.

REFERENCES

Abernathy, W. J., & Clark, K. B. (1985). Innovation: Mapping creative destruction. *Research Policy*, *14*, 3–22.

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review*, *84*(4), 98-107.

Al-Atabi, M., & Deboer, J. (2014). Teaching entrepreneurship using Massive Open Online Course (MOOC). *Technovation*, *34*(4), 261–264. https://doi.org/10.1016/j.technovation.2014.01.006

Ali, M., Hashim, N., & Ibrahim, A. (2017). The evaluations of Facebook as an educational technology tool in polytechnic's entrepreneurship courses. *Journal of Fundamental and Applied Sciences*, *9*(6S), 805–815. http://dx.doi.org/10.4314/jfas.v9i6s.60

Arenius, P., & Clercq, D. De. (2005). A network-based approach to opportunity recognition. *Small Business Economics*, *24*(3), 249–265. https://doi.org/10.1007/s11187-005-1988-6

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman and Company.

Baron, R. A., & Ensley, M. D. (2006). Opportunity recognition as the detection of meaningful patterns: Evidence from comparisons of novice and experienced entrepreneurs. *Management Science*, *52*(9), 1331–1344. https://doi.org/10.1287/mnsc.1060.0538

Bonesso, S., Gerli, F., Pizzi, C., & Cortellazzo, L. (2018). Students' entrepreneurial intentions: The role of prior learning experiences and emotional, social, and cognitive competencies. *Journal of Small Business Management*, *56*(00), 215–242. https://doi.org/10.1111/jsbm.12399

Byun, C. G., Sung, C. S., Park, J. Y., & Choi, D. S. (2018). A study on the effectiveness of entrepreneurship education programs in higher education institutions: A case study of Korean graduate programs. *Journal of Open Innovation: Technology, Market, and Complexity*, *4*(3), Article 26. https://doi.org/10.3390/joitmc4030026

Camelo-Ordaz, C., Diánez-González, J. P., Franco-Leal, N., & Ruiz-Navarro, J. (2020). Recognition of entrepreneurial opportunity using a socio-cognitive approach. *International Small Business Journal: Researching Entrepreneurship*, *38*(8), 718–745. https://doi.org/10.1177/0266242620939843

Chen, L., Ifenthaler, D., & Yau, J. Y.-K. (2021). Online and blended entrepreneurship education: a systematic review of applied educational technologies. *Entrep Educ*, *4*, 191–232. https://doi.org/10.1007/s41959-021-00047-7

Cheng, H., Bian, Q., & Mao, Q. (2022). How can Internet use and environmental risk perception encourage pro-environmental behaviors? The mediating role of government performance perception. *Polish Journal of Environmental Studies*, *31*(6), 5621–5631. https://doi.org/10.15244/pjoes/152225

Costa, S. F., Santos, S. C., Wach, D., & Caetano, A. (2018). Recognizing opportunities across campus: The effects of cognitive training and entrepreneurial passion on the business opportunity prototype. *Journal of Small Business Management*, *56*(1), 51–75. https://doi.org/10.1111/jsbm.12348

Cui, J., Sun, J., & Bell, R. (2021). The impact of entrepreneurship education on the entrepreneurial mindset of college students in China: The mediating role of inspiration and the role of educational attributes. *International Journal of Management Education*, *19*(1), Article 100296. https://doi.org/10.1016/j.ijme.2019.04.001

Deng, Y. (2021). Influence of social media on enterprise knowledge sharing based on social network analysis. *Entrepreneurship Research Journal*, *11*(2), 99–118. https://doi.org/10.1515/erj-2020-0245

Diaz Vidal, D., Pittz, T. G., Hertz, G., & White, R. (2021). Enhancing entrepreneurial competencies through intentionally designed podcasts. *International Journal of Management Education*, *19*(3), Article 100537. https://doi.org/10.1016/j.ijme.2021.100537

Fan, M., Qalati, S. A., Khan, M. A. S., Shah, S. M. M., Ramzan, M., & Khan, R. S. (2021). Effects of entrepreneurial orientation on social media adoption and SME performance: The moderating role of innovation capabilities. *PLoS ONE*, *16*(4), Article e0247320. https://doi.org/10.1371/journal.pone.0247320

Fellnhofer, K. (2022). Entrepreneurial alertness toward responsible research and innovation: Digital technology makes the psychological heart of entrepreneurship pound. *Technovation*, *118*, Article 102384. https://doi.org/10.1016/j.technovation.2021.102384

Fox, J., Pittaway, L., & Uzuegbunam, I. (2018). Simulations in entrepreneurship education: Serious games and learning through play. *Entrepreneurship Education and Pedagogy*, *1*(1), 61–89. https://doi.org/10.1177/2515127417737285

Galvão, A., Marques, C., & Ferreira, J. J. (2020). The role of entrepreneurship education and training programs in advancing entrepreneurial skills and new ventures. *European Journal of Training and Development*, *44*(6–7), 595–614. https://doi.org/10.1108/EJTD-10-2019-0174

Garson, G. D. (2016). Partial least squares: Regression and structural equation models. In *Statistical Associates Publishers*. Statistical Associates Publishers. https://doi.org/10.3726/978-3-0353-0280-6/8

Greene, F. J., & Saridakis, G. (2008). The role of higher education skills and support in graduate self-employment. *Studies in Higher Education*, *33*(6), 653–672. https://doi.org/10.1080/03075070802457082

Grégoire, D. A., Barr, P. S., & Shepherd, D. A. (2010). Cognitive processes of opportunity recognition: The role of structural alignment. *Organization Science*, *21*(2), 413–431. https://doi.org/10.1287/orsc.1090.0462

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). Multivariate data analysis. In *Pearson education limited* (7th ed.). Pearson Prentice Hall.

Hair, J. F., Black, W., C., Babin B., J., & Anderson R., E. (2009). *Multivariate data analysis* (7th ed.). Prentice Hall.

Handayati, P., Wulandari, D., Soetjipto, B. E., Wibowo, A., & Narmaditya, B. S. (2020). Does entrepreneurship education promote vocational students' entrepreneurial mindset? *Heliyon*, *6*(11), Article e05426. https://doi.org/10.1016/j.heliyon.2020.e05426

Hassan, H. M. K. (2020). Intention towards social entrepreneurship of university students in an emerging economy: the influence of entrepreneurial self-efficacy and entrepreneurship education. *On the Horizon*, *28*(3), 133–151. https://doi.org/10.1108/OTH-04-2020-0012

Heeks, R., Gomez-Morantes, J. E., Graham, M., Howson, K., Mungai, P., Nicholson, B., & Van Belle, J. P. (2021). Digital platforms and institutional voids in developing countries: The case of ride-hailing markets. *World Development*, *145*, Article 105528. https://doi.org/10.1016/j.worlddev.2021.105528

Horta, H., Meoli, M., & Vismara, S. (2016). Skilled unemployment and the creation of academic spin-offs: a recession-push hypothesis. *Journal of Technology Transfer*, *41*(4), 798–817. https://doi.org/10.1007/s10961-015-9405-z

Iansiti, M., & Levien, R. (2004). *The keystone advantages: What the new dynamics of business ecosystems mean for strategy, innovation and sustainability*. Harvard Business School Publishing Corporation.

Ilonen, S., & Heinonen, J. (2018). Understanding affective learning outcomes in entrepreneurship education. *Industry and Higher Education*, *32*(6), 391–404. https://doi.org/10.1177/0950422218805177

Kallinikos, J., Aaltonen, A., & Marton, A. (2013). The ambivalent ontology of digital artifacts. *MIs Quarterly, 37*(2), 357–370. http://www.jstor.org/stable/43825913

Kauppinen, A., & Iftikhar Choudhary, A. (2021). Gamification in entrepreneurship education: A concrete application of Kahoot! *International Journal of Management Education*, *19*(3), Article 100563. https://doi.org/10.1016/j.ijme.2021.100563

Kirzner, I. M. (1979). *Perception, opportunity, and profit: Studies in the theory of entrepreneurship*. University of Chicago Press.Kirzner, I. M. (1973). *Competition and entrepreneurship*. University of Chicago Press.

Krueger, N. F. (1989). The antecedents of opportunity recognition: The role of perceived self-efficacy [The Ohio State University]. *Journal of Allergy and Clinical Immunology*, *130*(2), 556-556. http://dx.doi.org/10.1016/j.jaci.2012.05.050

Liao, F., Li, A., Zhang, Q., & Yang, J. (2022). Recognizing opportunities when individual engaged in intrapreneurship: The role of creative self-efficacy and support for innovation. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.937971

Lomberg, C., Urbig, D., Stöckmann, C., Marino, L. D., & Dickson, P. H. (2017). Entrepreneurial orientation: The dimensions' shared effects in explaining firm performance. *Entrepreneurship: Theory and Practice*, *41*(6), 973–998. https://doi.org/10.1111/etap.12237

Lu, Y., & Jover, G. (2019). An anthroposophic view: What Confucian traditions can teach us about the past and future of Chinese higher education. *Higher Education*, *77*(3), 423–436. https://doi.org/10.1007/s10734-018-0280-z

Martínez-Gregorio, S., Badenes-Ribera, L., & Oliver, A. (2021). Effect of entrepreneurship education on entrepreneurship intention and related outcomes in educational contexts: a meta-analysis. *International Journal of Management Education*, *19*(3), Article 100545. https://doi.org/10.1016/j.ijme.2021.100545

Mary George, N., Parida, V., Lahti, T., & Wincent, J. (2016). A systematic literature review of entrepreneurial opportunity recognition: insights on influencing factors. *International Entrepreneurship and Management Journal*, *12*(2), 309–350. https://doi.org/10.1007/s11365-014-0347-y

Marzano, A., & Miranda, S. (2021). Online learning environments stimulate in students the processes of mutual interaction between digital and analog artifacts to enhance student learning. *MethodsX*, *8*, Article 101440. https://doi.org/10.1016/j.mex.2021.101440

Maurer, T. J., & Pierce, H. R. (1998). A comparison of the Likert scale and traditional measures of self-efficacy. *Journal of Applied Psychology*, *83*(2), 324–329. https://doi.org/10.1037/0021-9010.83.2.324

Mayer, I., Kortmann, R., Wenzler, I., Wetters, Á., & Spaans, J. (2014). Game-based entrepreneurship education: Identifying enterprising personality, motivation and intentions amongst engineering students. *Journal of Entrepreneurship Education*, *17*(2), 217–244.

Miller, K., Alexander, A., Cunningham, J. A., & Albats, E. (2018). Entrepreneurial academics and academic entrepreneurs: A systematic literature review. *International Journal of Technology Management*, *77*(1/2/3), 9–37. https://doi.org/10.1504/IJTM.2018.091710

Mohamed, N. A., & Sheikh Ali, A. Y. (2021). Entrepreneurship education: Systematic literature review and future research directions. *World Journal of Entrepreneurship, Management and Sustainable Development*, *17*(4), 644–661. https://doi.org/10.1108/WJEMSD-07-2020-0084

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., Secundo, G., Schiuma, G., & Passiante, G. (2018). Insights for shaping entrepreneurship education: Evidence from the European entrepreneurship centers. *Sustainability (Switzerland)*, *10*(11), Article 4323. https://doi.org/10.3390/su10114323

Oberländer, A. M., Röglinger, M., & Rosemann, M. (2021). Digital opportunities for incumbents – A resource-centric perspective. *Journal of Strategic Information Systems*, *30*(3), Article 101670. https://doi.org/10.1016/j.jsis.2021.101670

Orel, M. (2020). The potentials of virtual reality in entrepreneurship education. In L. Daniela (Ed.), *New perspectives on virtual and augmented reality: Finding new ways to teach in a transformed learning environment* (pp. 38-48). Routledge, Taylor and Francis Group. https://doi.org/10.4324/9781003001874-3

Ozgen, E., & Baron, R. A. (2007). Social sources of information in opportunity recognition: Effects of mentors, industry networks, and professional forums. *Journal of Business Venturing*, *22*(2), 174–192. https://doi.org/10.1016/j.jbusvent.2005.12.001

Ozgen, E., Campus, D., Minsky, B. D., & Campus, D. (2007). Opportunity recognition in rural entrepreneurship in developing countries. *International Journal of Entrepreneurship*, *11*, 49–74.

Ozgen, E., & Minsky, B. D. (2013). Why do some college students engage in entrepreneurial activities while others do not? *Journal of Entrepreneurship Education*, *16*(5), 51. https://doi.org/10.14233/ajchem.2023.28026

Parker, G., Alstyne, M. Van, & Jiang, X. (2017). Platform ecosystems: How developers invert the firm. *MIs Quarterly*, *41*(1), 255–266.

Perry-Smith, J. E. (2006). Social yet creative: The role of social relationships in facilitating individual creativity. *Academy of Management Journal*, *49*(1), 85–101. https://doi.org/10.5465/AMJ.2006.20785503

Prior, D. D., Mazanov, J., Meacham, D., Heaslip, G., & Hanson, J. (2016). Attitude, digital literacy, and self-efficacy: Flow-on effects for online learning behavior. *Internet and Higher Education*, *29*, 91–97. https://doi.org/10.1016/j.iheduc.2016.01.001

Ratten, V., & Jones, P. (2021). Entrepreneurship and management education: Exploring trends and gaps. *International Journal of Management Education*, *19*(1), Article 100431. https://doi.org/10.1016/j.ijme.2020.100431

Ratten, V., & Usmanij, P. (2021). Entrepreneurship education: Time for a change in research direction? *International Journal of Management Education*, *19*(1), Article 100367. https://doi.org/10.1016/j.ijme.2020.100367

Rosendahl Huber, L., Sloof, R., Van Praag, M., & Parker, S. C. (2020). Diverse cognitive skills and team performance: A field experiment based on an entrepreneurship education program. *Journal of Economic Behavior and Organization*, *177*, 569–588. https://doi.org/10.1016/j.jebo.2020.06.030

Santarelli, E., & Tran, H. T. (2013). The interplay of human and social capital in shaping entrepreneurial performance: The case of Vietnam. *Small Business Economics*, *40*(2), 435–458. https://doi.org/10.1007/s11187-012-9427-y

Secundo, G., Rippa, P., & Meoli, M. (2020). Digital transformation in entrepreneurship education centers: preliminary evidence from the Italian Contamination Labs network. *International Journal of Entrepreneurial Behaviour and Research*, *26*(7), 1589–1605. https://doi.org/10.1108/IJEBR-11-2019-0618

Sexton, D. L., & Bowman-Upton, N. B. (1991). *Entrepreneurship: Creativity and Growth*. Macmillan Pub Co.

Sigfusson, T., & Chetty, S. (2013). Building international entrepreneurial virtual networks in cyberspace. *Journal of World Business*, *48*(2), 260–270. https://doi.org/10.1016/j.jwb.2012.07.011

Singh, R. P. (2000). *Entrepreneurial Opportunity Recognition through Social Networks*. Garland Publishing, Inc.

Singh, R. P., Hills, G. E., Hybels, R. C., & Lumpkin, G. T. (1999). Opportunity recognition through social network characteristics of entrepreneurs. In *19th, Annual Entrepreneurship research conference; Frontiers of entrepreneurship research 1999* (pp. 228-241). https://www.tib.eu/en/search/id/BLCP%3ACN035973576/Opportunity-Recognition-Through-Social-Network/

Sobakinova, D., Zhou, Y., & Aureaar, K. A. A. (2019). Self-efficacy, opportunity recognition, and business ideas. *ACM International Conference Proceeding Series*, *ICEME '19*, 51–56. https://doi.org/10.1145/3345035.3345079

Steininger, D. M. (2019). Linking information systems and entrepreneurship: A review and agenda for IT-associated and digital entrepreneurship research. *Information Systems Journal*, *29*(2), 363–407. https://doi.org/10.1111/isj.12206

Subhash, S., & Cudney, E. A. (2018). Gamified learning in higher education: A systematic review of the literature. *Computers in Human Behavior*, *87*, 192–206. https://doi.org/10.1016/j.chb.2018.05.028

Tantawy, M., Herbert, K., McNally, J. J., Mengel, T., Piperopoulos, P., & Foord, D. (2021). Bringing creativity back to entrepreneurship education: Creative self-efficacy, creative process engagement, and entrepreneurial intentions. *Journal of Business Venturing Insights*, *15*(March), Article e00239. https://doi.org/10.1016/j.jbvi.2021.e00239

Tarabasz, A., Selaković, M., & Abraham, C. (2018). The classroom of the future: Disrupting the concept of contemporary business education. *Entrepreneurial Business and Economics Review*, *6*(4), 231–245. https://doi.org/10.15678/EBER.2018.060413

Thompson, N. A., & Illes, E. (2021). Entrepreneurial learning as practice: A video-ethnographic analysis. *International Journal of Entrepreneurial Behaviour and Research*, *27*(3), 579–599. https://doi.org/10.1108/IJEBR-10-2018-0663

Tumasjan, A., & Braun, R. (2012). In the eye of the beholder: How regulatory focus and self-efficacy interact in influencing opportunity recognition. *Journal of Business Venturing*, *27*(6), 622–636. https://doi.org/10.1016/j.jbusvent.2011.08.001

Vinogradova, M., Konstantinov, V., Prasolov, V., Lukyanova, A., & Grebenkina, I. (2019). Level entrepreneurship-role in the digital economy, tendencies of improvement of the information support system. *Journal of Entrepreneurship Education*, *22*(5).

von Briel, F., Davidsson, P., & Recker, J. (2018). Digital technologies as external enablers of new venture creation in the it hardware sector. *Entrepreneurship: Theory and Practice*, *42*(1), 47–69. https://doi.org/10.1177/1042258717732779

Vorbach, S., Maria Poandl, E., & Korajman, I. (2019). Digital entrepreneurship education: The role of MOOCs. *International Journal of Engineering Pedagogy*, *9*(3), 99–111. https://doi.org/10.3991/ijep.v9i3.10149

Wraae, B., Tigerstedt, C., & Walmsley, A. (2021). Using reflective videos to enhance entrepreneurial learning. *Entrepreneurship Education and Pedagogy*, *4*(4), 740–761. https://doi.org/10.1177/2515127420936955

Wu, D., Yang, X., Lu, C., Li, M., Wang, M., & Yang, W. (2023). Relationship between internet attitude and internet self-efficacy: ICT competence and network interaction as mediators. *Children and Youth Services Review*, *149*, Article 106916. https://doi.org/10.1016/j.childyouth.2023.106916

Yao, J., Wang, F., Jia, K., Han, B., Zhou, J., & Yang, H. (2021). Device-cloud collaborative learning for recommendation. In *Proceedings of the 27th ACM SIGKDD Conference on Knowledge Discovery & Data Mining* (pp. 3865-3874). https://doi.org/10.1145/3447548.3467097

Zhang, Z. (2021). The impact of digital technologies on entrepreneurship education: A literature review for progress and prospects. *Advances in Social Science, Education, and Humanities Research*, *543*(Icssed), 448–452. http://dx.doi.org/10.2991/assehr.k.210407.088

Żur, A. (2018). Changing entrepreneurship learning ecosystems: Massive open online courses. Opportunities and limitations. *Przedsiębiorczość – Edukacja*, *14*, 1–11.