Understanding, Assessing, and Facilitating Entrepreneurship Competence in the Digital Age

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Abstract

Entrepreneurship and entrepreneurship education become mainstream inside and outside business schools after scholarships and educators from this field made efforts in the past two decades. Nutrition of entrepreneurship competence is an emergency task for the economy and society especially during economic shock and uncertainty. Digital entrepreneurship competence brings new possibilities for learners living in this digital world. This study facilitates digital entrepreneurship and digital entrepreneurship competence as 21st-century skills at the higher education level, experimenting in Chinese universities and colleges. In addition, this research will help stakeholders in Germany and other countries whose learners lack such knowledge and skills. I propose a methodology set consisting of three main ingredients. Initially, a systematic review was undertaken by the researcher in collaboration with two educators who specialized in entrepreneurship theories and practice to extract insights on the utilization of educational technologies in the context of entrepreneurship education. In response to the current trend of educational technology, a comprehensive examination was conducted to scrutinize the regulations and potential of AI within entrepreneurship learning and teaching. Secondly, the present study endeavored to assess the effectiveness of virtual team learning in online entrepreneurship education during the COVID-19 pandemic, taking into consideration the dimensions of teamwork, taskwork, and information and communication technology. In the final investigation, a digital entrepreneurship training program was administered through an online platform, with the aim of obtaining both quantitative and qualitative feedback regarding the program's effectiveness and assessing the participants' digital entrepreneurship competence. The following presents a summary of each study:

Regarding the systematic review on the utilization of educational technologies in entrepreneurship education, Study 1 uncovered that social media, serious games, and digital platforms emerged as three prominent technological approaches. In light of extensive application of artificial intelligence in various educational domains, Study 2 delved into its utilization within the context of entrepreneurship education. The findings indicated the prevalence of machine learning, big data analysis, and adaptive

learning systems in this field. Meanwhile, the investigation identified potential prospects for the integration of natural language processing and chatbots in entrepreneurship teaching and learning.

I evaluated online entrepreneurship education courses, supported by virtual teams from existing freely available learning content and multimedia materials. Evaluation of the content and materials is whether they fit the needs of educators and learners with various demographic backgrounds. Specifically, we evaluated the influence of gender and other demographic backgrounds on virtual team learning and its impact on entrepreneurship competence.

Furthermore, experiential learning in online settings was explored in the field of entrepreneurship, focusing on the evaluation of an online practical entrepreneurship training program using the digital entrepreneurship competence framework. The research showed that *digital opportunity identification* competence is apparently improved from a complete novice to a nascent entrepreneur who understands the theory and practice of digital entrepreneurship. However, the effectiveness of online practical learning is limited because of participants' isolation. If possible, tutorials and project guides are conducted online whereas experiential learning is partly moved into face-to-face contexts.

To analyze entrepreneurship competence in the digital age, this thesis construct and discuss theoretical frameworks, namely entrepreneurship education, educational technology, and digital entrepreneurship competence. The current studies seldom analyze entrepreneurship competence in online entrepreneurship education programs. Therefore, this research attempts to understand, assess, and facilitate entrepreneurship competence and digital entrepreneurship competence in the digital age. The thesis consists of two qualitative studies (Study 1 and 3) and two quantitative studies (Study 2 and 4).

This research aims to offer valuable insights for developing countries engaging in entrepreneurship education with limited resources, enabling the younger generation to navigate the path of venture creation. It holds practical and theoretical implications, establishing a solid foundation for online entrepreneurship education and fostering digital entrepreneurship competence. It is hoped that this thesis will inspire scholars and policy-makers to actively contribute to this field and work collaboratively.

A wise man will make more opportunities than he finds.

Francis Bacon

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1 Introduction

1.1 Motivation

Social problems, such as high inflation, the energy crisis, and environmental protection, faced by all mankind, should be paid attention to solve as soon as possible (Atkinson, 2019; Pietrosemoli & Rodríguez-Monroy, 2019; Thomas et al., 2019). On one side, relevant to evolutionary economics, entrepreneurship, especially social entrepreneurship provides possible innovative solutions to quench the public's agitation and stimulate economic growth and development (Brouwer, 2002; Carree & Thurik, 2010; Sarasvathy, 2001; Śledzik, 2013), different from neo-classical microeconomics with certainty. On the other side, learning can release anxiety and fear about uncertainty and risks of the future and performance with regard to individuals and organizations (Lumpkin & Lichtenstein, 2005; Russell, 2020). The two sides above partly interpret why entrepreneurship and entrepreneurship education (EE) is a main branch in business schools, strongly supported by policy-makers for both self-employment and paid employment. Furthermore, most scholars examined that learners completing EE have higher intentions to launch a business than those who did not (Jena, 2020; Liñán, 2004; Forster-Holt, 2021; Liu et al., 2019; Oosterbeek et al., 2010; Wilson et al., 2007; Küttim et al., 2014; Turker & Selcuk, 2009) whereas a study found EE has a negative influence on male German learners entrepreneurial intention (see in Packham et al., 2010) because of theory-based learning (i.e., lectures and seminars) (Lima et al., 2015).

Main economic entities initiate EE in their formal educational system. In the United States, EE activities start from K12 (education effectiveness is complicated) (Moberg, 2014) to beyond business schools of higher education levels where EE budded in 1947 and course diversity grew in the 1990s (Pittaway, 2021; Solomon, 2007). Universities in Germany and western European developed economies (i.e., France) provide EE programs and organization associations for future entrepreneurs and their stakeholders at the bachelor, master, and Ph.D. levels. EE is embedded in UK higher education systems through hands-on activities with government support, for example, the UK government published *Enterprise and EE: Guidance for UK Higher Education Providers* in 2018. North Europe countries, especially Sweden and Finland, set EE

objectives for all levels of formal education and lifelong learning. In China, innovative and EE activities are compulsory for all enrolled students with two or more academic credits in higher education. In general, educational and structural support from policymakers and educators enhances students' entrepreneurship motivation and economic development, leading to EE as a subject that has been deployed in higher education systems worldwide.

Delivery of EE is mainly F2F on campus, as well as chamber of Commerce and Massive Open Online Courses (MOOCs) platforms in the history of EE. Online EE courses are designed by top-tier business schools to provide degrees or certifications, facilitating learners with various demographic backgrounds to study together and learn from each other on MOOCs platforms (Lambert, 2020) in the past twenty years. Because of COVID-19, Chinese and beyond entrepreneurial educators have had to transfer lectures and activities to online and hybrid environments, although online education is not novel for business and management education. At present, Chinese higher education institutes (HEIs) still provide EE courses and activities remotely from time to time. Meanwhile, informal educational organizations or third parties (i.e., EE associations) design online courses and train learners from different universities and backgrounds across mainland China (Liñán, 2004), supplementing the resources shortage of formal education. Additionally, educators from the business area maintain parts of postgraduate and undergraduate courses online, i.e., case study presentations, because of time-saving and requirements of the digital age (Pavlidou et al., 2021). Based on the broad objectives of EE (both potential entrepreneurs who want to start a business in the future and employees who need to acquire this competence in launching new products or expanding markets), the online learning environment easily broadcasts entrepreneurship knowledge that each enrolled learner in Chinese HEIs should master without time and space limitation. Learners gain entrepreneurship skills and mindset, however, through practical and experiential approaches (Liguori & Winkler, 2020) that are challenging and cause anxiety in the online context because of less connectedness and more isolation (Russell, 2020). Hence, interaction enhancement in online settings is through team learning (see Study 3) among members and the application of educational technology.

With the development of educational technology and the digitalization of education, online EE breaks the boundaries of the traditional face-to-face (F2F) learning environment. Following data privacy protection regulations, educators and software developers retrieve big data related to learners' learning behavior, i.e., learning time, to predict learning success and adjust teaching procedures, from online, classroom, to home (Ifenthaler, 2017; Ifenthaler et al., 2022; Leitner et al., 2017). Entrepreneurial educators and tutors adopted technologies to the current venture creation curriculum, shown in the first and second studies. On the one side, social media and gamification increase attraction, retention, and entrepreneurial intention for online participants (Ruiz-Alba et al., 2019). On the other side, artificial intelligence (AI), as educational technology, applies algorithms to educational problem solutions and decision-making, learning from datasets. Specifically, machine learning learns from trained sets (datasets for training algorithms), achieving appropriate algorithms used in new sets. Natural language processing facilitates learners and computer interaction. Robotics takes over the repeated workload from instructors, especially in the question-and-answer section and evaluation of structured assignments. Personalized/Adaptive learning management systems provide individualized learning content and suggestions for learners. Therefore, the deep application of AI in EE will be one of the most important trends in the near future (Cirulli et al., 2016; Holinska et al., 2019).

Under digital transformation and the development of digital infrastructure, the digital economy increases drastically and digital entrepreneurship opportunities explore in almost all economic sectors (Hu\djek et al., 2019; Kraus et al., 2018). Launching a digital venture, i.e., digital products and their online marketing, will probably produce a large number of economic benefits. Therefore, the fourth study analyzed learners' digital entrepreneurship competence through an online training program. Studies of digital entrepreneurship competence combine digital competence and entrepreneurship competence superficially (e.g., Ngoasong, 2017; Hu\djek et al., 2019). Or scholars take digital competence as subordinate to the entrepreneurship competence (e.g., Kurmanov et al., 2020). Based on European Union's entrepreneurship competence framework and digital competence framework, the built digital entrepreneurship competence (EmDigital) framework is more scientific and goes further than the other

research (Prendes-Espinosa et al., 2021). A series of academic results have been published publicly since 2017 in both English and Spanish. However, the application of this EmDigital framework in practice needs to be demonstrated by front-line educators. The fourth study applied this framework to an online practical entrepreneurship training program, supplied by individual reflection and group tasks, as well as educators' evaluations. The entrepreneurship training program simulates the real venture creation process and its standardizing steps are set on a learning management system. With detailed descriptions of each step, users manipulate and follow steps by themselves to validate their solutions to problems and business models. Online entrepreneurship training programs can release the dearth of experienced teachers and the restriction policy for formal education. Practical activities provide a chance to train and master entrepreneurial skills and mindset, as well as improve learning motivation. Limited by programming skills, most teams struggled with designing a digital product or service in eight weeks. Therefore, an practical entrepreneurship training program was adopted in the fourth study to facilitate learners' digital entrepreneurship competence, increase entrepreneurship intention, and combine theory and practice (Forster-Holt, 2021).

Regarding the circumstance of the reinforcement of digitalization, understanding, assessing, and facilitating entrepreneurship competence is a necessary and urgent topic for entrepreneurship educators and stakeholders in both developed and developing economic entities. Although F2F learning settings are more welcome by learners and educators, online EE can release the dearth of experienced educators and the sudden breakthrough by natural disasters or pandemics. Furthermore, the digitalization transformation of higher education in teaching, learning contents, learning methods, and places are happing during the new normal caused by COVID-19 (García-Morales et al., 2021; Krishnamurthy, 2020). Therefore, this thesis focuses on an online learning environment to analyze entrepreneurship competence and digital entrepreneurship competence (Study 2 and Study 4).

With the efforts of entrepreneurship scholars and educators, entrepreneurship and EE are prominent in business schools. Entrepreneurship academic findings are published in entrepreneurship journals and presented at Academy of Management annual conferences. Well-structured frameworks of entrepreneurship competence and digital

competence have been built and are widely used worldwide. However, in the digital environment, EE lags behind, compared with other disciplines. To enhance the influence of entrepreneurship as a subject, research on educational technology pedagogy, entrepreneurship pedagogy, and online education pedagogy (learned from online language pedagogy) (see Russell, 2020), namely online entrepreneurship pedagogy is of great necessity, which is less discussed in this field (Liguori & Winkler, 2020). Additionally, entrepreneurship competence and digital entrepreneurship competence should be further studied from practical aspects since the current frameworks still have gaps to employ in the individual learning assessment and measurement (Bacigalupo et al., 2016). Likewise, because experiential learning is mainly conducted in F2F learning settings, online experiential learning in EE lacks practical evidence and theoretical studies to give hints to practitioners and academic counterparts who lack experience in online education environments (Mensah et al., 2022; Liguori & Winkler, 2020). Furthermore, with the booming development of Chinese EE, especially digital EE, such as digital content, digital applications, and digital platforms, there are few influential publications studying this country and its practice, which might inspire Germany and other economic entities. That is why the last two studies of this thesis collected data from China. Additionally, we can learn from top-level research and practice of education digitalization in China and Asia. Because of the development of education digitalization and the Zero-COVID policy in China, educators and learners from all educational levels are familiar with online teaching and learning, although the opponents disagree with online education. Therefore, this thesis assesses entrepreneurship competence and digital entrepreneurship competence through online and blended learning activities by use of educational technologies in China.

1.2 Research question of this thesis

As mentioned above, entrepreneurship competence and digital entrepreneurship competence are essential for 21st-century citizens and organizations. Digital transformation and digital economy in institutions, industries, and societies are highly relevant to each entrepreneur, facilitating digital entrepreneurship (Nambisan, 2017; Vial, 2021). The would-be entrepreneurs should acquire both entrepreneurship competence and digital competence during entrepreneurship-initiating endeavors.

When other European research organizations are designing digital entrepreneurship competence frameworks, Prendes-Espinosa and her colleagues (2021) have coined and modified the digital entrepreneurship competence model for the assessment of learners who enroll in higher education systems. However, its application in practice needs to be further experimentally demonstrated. Additionally, online EE has originated and developed in the past twenty years. The digital learning environment is a challenge for EE because of the requirement of the "learning by doing" method (Colombelli et al., 2022; Forster-Holt, 2021) and EE is a generative process among attendants (Huntsley & Brentnall, 2021). Online EE is constricted by fewer connections and contexts than F2F environments. Virtual team learning adds communication and collaboration possibilities among learners. Additionally, educational technology, i.e., AI, supports online EE and irritates learning contents and learning methods (Ratten & Jones, 2021). The effectiveness of online EE needs to be studied with more scholars' participation (Liguori & Winkler, 2020). Motivated by these research problems, this research examines online EE for entrepreneurship competence in the digital age. The four sub-studies with key themes to be analysed are shown below:

- The research statutes of educational technology applied in EE were systematically reviewed.
- The research status quo and foreseeable future of AI used in EE were reviewed.
- How is the effectiveness of virtual team learning from team tasks, team relationships, and information and communication technology (ICT)?
- How is an online practical entrepreneurship training program to gain digital entrepreneurship competence?

The four studies were conducted through systematic review and scoping review, as well as quantitative and qualitative methods correspondingly to analyze the effectiveness of virtual team learning and study on an online entrepreneurship training program by an existing digital entrepreneurship competence framework.

In conclusion, the research aims to understand what ingredients entrepreneurship competence consists of and assess this competence of higher education students, as well as digital entrepreneurship competence in online and blended learning

environments, facilitating research and development of online and blended EE. The following section will discuss the research questions specifically.

1.3 Specific research questions

Figure 1-1 shows the general picture of research foci and four studies to know the entrepreneurship competence and digital entrepreneurship competence acquired in online and blended learning environments through formal and informal venture creation activities. Furthermore, Table 1-1 provides an overview of the four mentioned studies regarding research approaches, sample sizes, and main foci of interest.

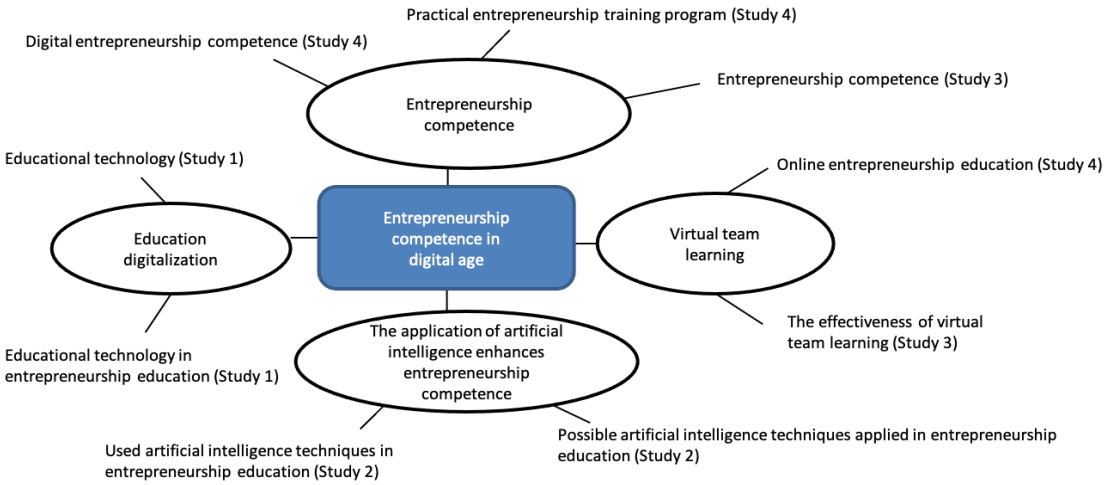

Figure 1-1 Overview of the research foci of the thesis and the related research

Table 1-1 Overview of papers and research studies included in this thesis

Study Chapter	Study 1 Chapter 3	Study 2 Chapter 5	Study 3 Chapter 4	Study 4 Chapter 6
Reference	Chen, L., Ifenthaler, D., & Yau, J. Y.-K. (2021). Online and Blended EE: A Systematic Review of Applied Educational Technologies. EE, 4(2), 191–232.	Chen, L., Ifenthaler, D., Sun, W., Xu, T., & Yan, G. (2022). Effectiveness of virtual team learning in EE: A survey study. EE, 5(1), 69–95.	Chen, L., Ifenthaler, D., & Yau, J. (under review). AI in EE: A Scoping Review. The International Journal of Management Education	Chen, L. & Ifenthaler, D. (under revise). Investigating Digital Entrepreneurship Competence in an Online Practical Program. The International Journal of Management Education
Research design	Qualitative research approach	Quantitative researchapproach	Qualitative research approach	Quantitative and qualitative research approach
Methods	Systematic review	Questionnaire survey	Scoping review	Questionnaire survey and interview both learners and tutors
Sample size	N = 38	N = 802	N_{ed} = 10 N_{ee} = 11	$N_{questionnaire}$ = 48 $N_{interview}$ = 19 ($N_{student}$ = 15, N_{tutor} = 4)
Research foci	Investigation of educational technologies applied in EE: - Social media - Serious games - Digital platforms - Comparison between the three technologies	Investigation of virtual team learning for EE during COVID-19: - Input: individual characteristics - Mediators: teamwork, taskwork, and ICT -Output: the effectiveness of virtual team learning for entrepreneurship competence	Summering AI used in EE, as well as education: - Big data analytics - Machine learning - Adaptive/personal learning system And potential sub- AI technologies used in EE: - Natural language processing - Chatbots	Investigating learners and educators' feedback on an online practical entrepreneurship training program: -Learning -Teaching -Curriculum And knowing teachers and learners reported on digital entrepreneurship competence: -Opportunities identification -Action planning -Initiation and collaboration -Management

1.3.1 Educational technology applied in EE (Study 1 and 2)

The first paper (Chapter 3) systematically reviewed educational technologies applied in EE to know its status quo at that time point. The research questions of Study 1 are shown thereafter:

- How are serious games, social media, and digital platforms (mainly MOOCs) technologies applied in online and blended EE?
- What are the strengths and weaknesses of serious games, social media, and digital platforms (mainly MOOCs) in online and blended EE?

Then I used scoping review to collect literature about the application of AI in both EE (*N* = 11) and other education fields (*N* = 10) in the second paper (Chapter 4). Here are four solved questions:

- What AI technologies have been applied to education?
- What related theoretical frameworks, especially the pedagogical design of AI in education have been developed?
- What specific AI technologies have been utilized in EE?
- What other AI technologies can be used in EE basis on the applicated AI applied in other educational fields?

1.3.2 Entrepreneurship competence (Study 3 and 4)

Reviewed entrepreneurship competence research, I found entrepreneurship competence framework constructed by European Union was widely adopted by entrepreneurial scholars. However, front-line educators think this framework is difficult to assess students' learning performance because of its complicated and inclusive elements. Similarly, although the digital entrepreneurship competence framework was published in English and other languages, shreds of practice evidence of its application still need to be given. So, entrepreneurship competence and digital entrepreneurship competence were studied as half part of study 3 (chapter 5) and study 4 (chapter 6) separately. The following is specific questions:

- What are the elements of entrepreneurship competence?
- How to use the entrepreneurship competence framework?
- How to use the digital entrepreneurship competence framework in practice?
- What are the results of the application of the digital entrepreneurship competence framework?

- How to iterate the digital entrepreneurship competence framework?

1.3.3 Virtual team learning (Study 3 and 4)

The third research (Chapter 5) mainly aims to analyze virtual team learning that was experimented with virtual taskwork, teamwork, and ICT, as well as considering individual personality. The specific questions are displayed below:

- Does virtual taskwork have a positive effect on entrepreneurship competence?
- Does virtual teamwork have a positive effect on entrepreneurship competence?
- Does ICT have a positive effect on entrepreneurship competence?
- Does individual characteristics (gender, education degree, education field, family entrepreneurial history, and prior entrepreneurial experience) affect virtual taskwork, teamwork, and ICT?

The virtual team was adopted to master entrepreneurship knowledge and mindset, less emphasizing entrepreneurial skills in an online learning environment.

1.3.4 Online practical entrepreneurship training (Study 4)

The fourth study (Chapter 6) experimented with an online practical entrepreneurship training program (O-PETP) from pedagogy aspects, namely learning, teaching, and curriculum sections. At the same time, I assessed digital entrepreneurship competence basis on the Digital Entrepreneurship Competence Framework, including digital entrepreneurship opportunity identification, initiation &collaboration, action planning, and management & safety by use of questionnaires and interview surveys participated by both tutors and learners. The sub-questions are solved thereafter:

- How is the feedback on the online practical entrepreneurship training project?
- How is learners' digital opportunity identification competence after O-PETP?
- How is learners' action planning competence after O-PETP?
- How is learners' management competence after O-PETP?
- How is learners' initiation and collaboration competence after O-PETP?

1.4 Structure of the thesis

This thesis with seven chapters consists of four separate completed research papers (two published and two under review). The first chapter interprets the necessity and research gap for understanding, assessing, and facilitating entrepreneurship competence and digital entrepreneurship competence in the digital age. Then the research questions of four papers from both general and specific sides are described and the thesis structure used a table and a figure is shown above. The second chapter emphasizes the theoretical framework of this thesis. Online EE, educational technology, and entrepreneurship competence are the main theories and concepts when discussing EE in the digital age, especially for digital entrepreneurship competence in an online education context. Online EE struggles with pedagogical theory and lacks interaction amongst distributed learners to launch a product or service. Educational technologies mitigate the above-mentioned shortcomings and bring new opportunities in online and blended learning settings. During the process, the assessment of entrepreneurship competence and digital entrepreneurship competence aims to iterate online entrepreneurship training programs in teaching, learning, and curriculum design for higher education students.

The following four sections integrate four sub-studies. Chapter three introduces educational technologies applied in EE (Study 1). The next chapter focuses on the status quo of AI in EE and other educational fields and analyses its possible application in the later future (Study 2). Chapter five analyses virtual team learning where participants adopted social media in online EE for acquiring entrepreneurship knowledge and mindsets (Study 3). Chapter six goes further on a practical entrepreneurship training program through an enterprise collaboration platform and a digital entrepreneurship learning system designed by our team (study 4). The last chapter discusses the research results in general, implications, limitations, and further research, as well as a conclusion of this thesis.

References

Atkinson, A. B. (2019). Measuring poverty around the world. In Measuring Poverty around the World. Princeton University Press.

Bacigalupo, M., Kampylis, P., Punie, Y., & Van den Brande, G. (2016). EntreComp: The entrepreneurship competence framework. Luxembourg: Publication Office of the European Union, 10, 593884.

Brouwer, M. T. (2002). Weber, Schumpeter and Knight on entrepreneurship and economic development. Journal of Evolutionary Economics, 12(1), 83–105.

Carree, M. A., & Thurik, A. R. (2010). The impact of entrepreneurship on economic growth. In Handbook of entrepreneurship research (pp. 557–594). Springer.
Cirulli, F., Elia, G., Lorenzo, G., Margherita, A., & Solazzo, G. (2016). The use of MOOCs to support personalized learning: An application in the technology entrepreneurship field. Knowledge Management & E-Learning: An International Journal, 8(1), 109–123.
Colombelli, A., Panelli, A., & Serraino, F. (2022). A Learning-by-Doing Approach to EE: Evidence from a Short Intensive Online International Program. Administrative Sciences, 12(1), 16.
Forster-Holt, N. (2021). Stimulation versus simulation: The student side hustle as a learning innovation. EE and Pedagogy, 4(4), 808–829.
García-Morales, V. J., Garrido-Moreno, A., & Martín-Rojas, R. (2021). The transformation of higher education after the COVID disruption: Emerging challenges in an online learning scenario. Frontiers in Psychology, 12, 616059.
Holinska, T., Komarovska, O., Melnyk, O., Pet'ko, L., Shpitsa, R., Sova, O., & Strohal, T. (2019). Cloud technologies in art EE. Journal of EE, 22(5), 1–6.
Hu\djek, I., Širec, K., & Tominc, P. (2019). Digital skills in enterprises according to the European digital entrepreneurship sub-indices: Cross-country empirical evidence. Management: Journal of Contemporary Management Issues, 24(2), 107–119.
Huntsley, J., & Brentnall, C. (2021). Generative critical conversation: A method for developing reflexivity and criticality. Journal of Small Business Management, 1–30.
Ifenthaler, D. (2017). Are higher education institutions prepared for learning analytics? TechTrends, 61(4), 366–371.
Ifenthaler, D., Schumacher, C., & Kuzilek, J. (2022). Investigating students' use of self-assessments in higher education using learning analytics. Journal of Computer Assisted Learning.
Jena, R. K. (2020). Measuring the impact of business management Student's attitude towards EE on entrepreneurial intention: A case study. Computers in Human Behavior, 107, 106275.
Kraus, S., Palmer, C., Kailer, N., Kallinger, F. L., & Spitzer, J. (2018). Digital entrepreneurship: A research agenda on new business models for the twenty-first century. International Journal of Entrepreneurial Behavior & Research.
Krishnamurthy, S. (2020). The future of business education: A commentary in the shadow of the Covid-19 pandemic. Journal of Business Research, 117, 1–5.
Kurmanov, N., Aliyeva, Z., Kabdullina, G., & Mutaliyeva, L. (2020). Digital entrepreneurship competencies among students: Methodological aspects of the maturity level and development program making. Journal of EE, 23(2), 1–11.
Küttim, M., Kallaste, M., Venesaar, U., & Kiis, A. (2014). EE at University Level and Students' Entrepreneurial Intentions. Procedia - Social and Behavioral Sciences, 110, 658–668. https://doi.org/10.1016/j.sbspro.2013.12.910
Lambert, S. R. (2020). Do MOOCs contribute to student equity and social inclusion? A systematic review 2014–18. Computers & Education, 145, 103693. https://doi.org/10.1016/j.compedu.2019.103693
Leitner, P., Khalil, M., & Ebner, M. (2017). Learning analytics in higher education—A literature review. Learning Analytics: Fundaments, Applications, and Trends, 1–23.
Liguori, E., & Winkler, C. (2020). From offline to online: Challenges and opportunities for EE following the COVID-19 pandemic. In EE and Pedagogy (Vol. 3, Issue 4, pp. 346–351). SAGE Publications Sage CA: Los Angeles, CA.
Lima, E., Lopes, R. M., Nassif, V., & Silva, D. (2015). Opportunities to improve EE: Contributions considering Brazilian challenges. Journal of Small Business Management, 53(4), 1033–1051.
Liñán, F. (2004). Intention-based models of EE. Piccolla Impresa/Small Business, 3(1), 11–35.

Lumpkin, G. T., & Lichtenstein, B. B. (2005). The role of organizational learning in the opportunity–recognition process. Entrepreneurship Theory and Practice, 29(4), 451–472.
Mensah, M. S., Arthur, K. N., & Mensah-Williams, E. (2022). Experiential Learning in Online EE: Lessons from an Undergraduate Entrepreneurship Course. In Theorising Undergraduate EE (pp. 333–351). Springer.
Moberg, K. (2014). Two approaches to EE: The different effects of education for and through entrepreneurship at the lower secondary level. The International Journal of Management Education, 12(3), 512–528.
Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. Entrepreneurship Theory and Practice, 41(6), 1029–1055.
Ngoasong, M. Z. (2017). Digital entrepreneurship in a resource-scarce context: A focus on entrepreneurial digital competencies. Journal of Small Business and Enterprise Development.
Packham, G., Jones, P., Miller, C., Pickernell, D., & Thomas, B. (2010). Attitudes towards EE: A comparative analysis. Education+ Training, 52(8/9), 568–586.
Pavlidou, I., Dragicevic, N., & Tsui, E. (2021). A multi-dimensional hybrid learning environment for business education: A knowledge dynamics perspective. Sustainability, 13(7), 3889.
Pietrosemoli, L., & Rodríguez-Monroy, C. (2019). The Venezuelan energy crisis: Renewable energies in the transition towards sustainability. Renewable and Sustainable Energy Reviews, 105, 415–426.
Pittaway, L. (2021). EE in Higher Education: A Review of the US Context. Available at SSRN 3942514.
Prendes-Espinosa, P., Solano-Fernández, I. M., & García-Tudela, P. A. (2021). EmDigital to promote digital entrepreneurship: The relation with open innovation. Journal of Open Innovation: Technology, Market, and Complexity, 7(1), 63.
Ratten, V., & Jones, P. (2021). Covid-19 and EE: Implications for advancing research and practice. The International Journal of Management Education, 19(1), 100432.
Ruiz-Alba, J. L., Soares, A., Rodríguez-Molina, M. A., & Banoun, A. (2019). Gamification and entrepreneurial intentions. Journal of Small Business and Enterprise Development.
Russell, V. (2020). Language anxiety and the online learner. Foreign Language Annals, 53(2), 338–352.
Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. Academy of Management Review, 26(2), 243–263.
Śledzik, K. (2013). Schumpeter's view on innovation and entrepreneurship. Management Trends in Theory and Practice,(Ed.) Stefan Hittmar, Faculty of Management Science and Informatics, University of Zilina & Institute of Management by University of Zilina.
Solomon, G. (2007). An examination of EE in the United States. Journal of Small Business and Enterprise Development, 14(2), 168–182.
Thomas, R. S., Bahadori, T., Buckley, T. J., Cowden, J., Deisenroth, C., Dionisio, K. L., Frithsen, J. B., Grulke, C. M., Gwinn, M. R., & Harrill, J. A. (2019). The next generation blueprint of computational toxicology at the US Environmental Protection Agency. Toxicological Sciences, 169(2), 317–332.
Turker, D., & Selcuk, S. S. (2009). Which factors affect entrepreneurial intention of university students? Journal of European Industrial Training.
Vial, G. (2021). Understanding digital transformation: A review and a research agenda. Managing Digital Transformation, 13–66.

2 Conceptual foundation of the thesis

2.1 Online entrepreneurship education

2.1.1 Entrepreneurship education

From individual aspects, entrepreneurship and informal entrepreneurship education existed long before Industrial Revolution (Casson & Casson, 2014). The definition of entrepreneur was first described by Richard Cantillion in the 18th century (Hébert & Link, 2009). The tenant rents land from a landlord in the Feudal age, being seen as entrepreneurship by Francois Quesnay. Economic theory underpins Schumpeter and Kirzner who is representative of the Austrian to interpret entrepreneurship (Kirzner, 1992; Schumpeter & Backhaus, 2003). Entrepreneurship is "examination of how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited"(Shane & Venkataraman, 2000, p.218). Formal entrepreneurship education appeared in the middle of the last century at Harvard University and later in the American Master of Business Administration (MBA) course, developing in the 1990s and booming in 2000 inside and outside of business schools in the United States and beyond including both developed and developing economies(Gibb, 2005). The European cultures and mature markets, especially Germany, produce almost static and ordered economies (Tracey & Phillips, 2011). Their entrepreneurship and entrepreneurship education lag behind that of the United States with the dynamic and innovative economy and the people believe "American Dream" (Crescenzi et al., 2007; Potter, 2008). Therefore, European policymakers executed many initiatives to chase the trend. For example, the implementation of the Bologna Process facilitated European universities and colleges to be more innovative and entrepreneurial (Keeling, 2006). Additionally, the European Commission built a well-known entrepreneurship competence framework containing three competence areas and 15 specific competencies to guide entrepreneurial academics and processes (Bacigalupo et al., 2016). Chinese entrepreneurship education took root at the end of the last century as entrepreneurial competitions (TiaoZhanbei) among a few of universities. Lately, different types of entrepreneurship competitions and activities such as *Internet+ Innovation and Entrepreneurship Competition, College Students Innovation, Originality, and Entrepreneurship Challenge* are organized by universities, governments (both local and national), organizations, and the Chamber of Commerce,

inspiring attendees' interests and facilitating competence development. The entrepreneurship curriculum boomed in the past ten years since the Chinese Ministry of Education took the entrepreneurial course as a formal academic program and compulsory course, attaining legitimacy in HEIs (Maritz et al., 2015; Li et al., 2016). Entrepreneurial competitions and compulsory courses become the main method to manipulate entrepreneurship education in this country. At the same time, entrepreneurship education is a general education at the beginning and it also becomes a major education conducted in thirteen universities and colleges in and out of business schools in the year 2022 (MEPRC,2022). Additionally, third-party organizations (profit and nonprofit) provide entrepreneurship training activities and resources to nurture talents and incubate ventures.

We should know what is entrepreneurship education before discussing other relevant topics. Although the definition has been given many times in almost each relevant academic work, there is no universally agreed-upon proposed definition. The highly cited scholars defined entrepreneurship education from how to acquire it, namely "in/about, for, and through entrepreneurship" (Gibb, 2005; Heinonen & Hytti, 2010). Different from the first two, 'through entrepreneurship' is learners start a business in the real world. The terminology of entrepreneurship education is categorized into narrow and broad definitions (Fellnhofer, 2019). The narrow definition is an instruction in identifying commercial opportunities and launching a business (Jones & English, 2004) by 'through entrepreneurship'. On the other side, the broad definition emphasizes career development and a valuable life (Fejes et al., 2019), acquiring entrepreneurship knowledge, skill, and mindset valuable in other scenarios through 'in and for entrepreneurship'. The given definition is highly relevant to the objective of entrepreneurship education in each study.

'Entrepreneurs are born' was proved wrong, or partly wrong (Kuratko, 2005). Experiments and quantitative studies, prove to be an entrepreneur can be learned or encouraged (Barba-Sánchez & Atienza-Sahuquillo, 2018; Fayolle & Gailly, 2015; Liñán, 2004; Sánchez, 2013), even entrepreneurship curricula and activities impact entrepreneurial behaviors (Rauch & Hulsink, 2015; Nabi et al., 2017), which is a hot-spot academic topic in the past twenty years when entrepreneurship curriculum was executed in higher education systems worldwide (Henry et al., 2005). Entrepreneurship

is based on not only nascent entrepreneur' traits but also opportunities (Eckhardt & Shane, 2003; Gartner, 1988). Studies analyzed factors of the effectiveness of entrepreneurship education, where psychological ingredients, entrepreneurial intention, and self-efficacy were identified in the past two decades (Liu et al., 2019; Oosterbeek et al., 2010; Wilson et al., 2007). Entrepreneurship education can be seen in all levels of formal education from elementary to postgraduate education (Brüne & Lutz, 2014; Saptono & Najah, 2018). However, HEIs providing entrepreneurship activities is mainstream. Furthermore, university-based incubators transfer technology, commercialize academic research and give a series of supports from the budding period to business scaling, such as social networking, free office support, facility supplement, or management consulting, building an entrepreneurship education ecosystem (Liu et al., 2021; McAdam & Marlow, 2008). Entrepreneurship can be seen not only as a major in business school, e.g., Babson College set entrepreneurship as its only major to encourage undergraduates to start a business before their graduation, but also as a general discipline for those who study other social science (Turner & Gianiodis, 2018), as well as Science, Technology, Engineering, Arts, and Mathematics (STEAM) students, e.g., Chinese and Colombia HEIs set entrepreneurship education as a compulsory course for all enrolled students. Entrepreneurship learning and teaching methods emphasize practical activities and collaborative behaviors and intelligence. Entrepreneurial learning and teaching methods include passive (i.e., guest speaker, seminars, and tutorials) and active participation (i.e., case studies and designation of prototype or minimal value products). The passive methods are least effective for cultivating entrepreneurship mindsets and mastering skills whereas learners positively participate in courses through the latter to become self-employed (Kosslyn, 2021). The two clusters basis on learners' intention or motivation (Taatila, 2010), where the educational philosophy is similar to what an ancient Chinese educator, Confucius mentioned. In another way, entrepreneurship education courses are categorized into two streams, practice-/experiential- and theoretical- orientation separately. Teaching methods, such as pitch, designation of prototypes, business plan, or business model are easily seen in experiential-based courses whereas learners attend lectures, prepare presentations, and complete paper-pencil homework in the theory-based curriculum. In other words, learners master entrepreneurial skills and mindsets through doing and its reflection

(Colombelli et al., 2022; Jones & English, 2004). Meanwhile, entrepreneurship educators introduce entrepreneurship theory and knowledge in their lecture courses with attention from teaching to learning (Hägg & Gabrielsson, 2019). They sometimes apply case studies and guest speakers to theory explanations. For example, one entrepreneurship introduction course at a German university provides four cases to learn in groups and five guest speakers for postgraduates in one semester. The theoretical part of the course plants an entrepreneurship seed for students who struggle with their majors at this moment. Depending on their major backgrounds, they might start their own business after five years of being employed. Or they stay in the institution to explore a new market or start an intrapreneurship in the near future. In any case, the objectives of entrepreneurship education underpin applying appropriate methods to chosen learning content. In a nutshell, entrepreneurship education provides lectures, case studies, experimental learning, and real-life experiences to develop learners' entrepreneurial knowledge, skills, and mindsets or views toward creating and operating a venture successfully, developing a career, or having a valuable life (Fejes et al., 2019).

Entrepreneurship education curriculums conducted in HEIs have a long history and their theoretical research has been systematically reviewed (Fellnhofer, 2019; Nabi et al., 2017; Pittaway & Cope, 2007). However, entrepreneurship pedagogy and didactics need to be further discussed with entrepreneurship educators and instructors in the digital age (Liguori & Winkler, 2020). Here list of main entrepreneurship education theories applied by scholars and educators. With regard to the effectiveness of entrepreneurship education, human capital theory (Ardichvili et al., 2003), entrepreneurial self-efficacy (Liu et al., 2019; Wardana et al., 2020), the theory of planned behavior (Ajzen, 1991), self-determination (Boldureanu et al., 2020), are widely used as theoretical frameworks. Human capital, such as formal education in schools, and informal education in the workplace and family, is non-linear with entrepreneurship intention and entrepreneurship success (Davidsson & Honig, 2003; Unger et al., 2011). In light of psychological traits, entrepreneurial self-efficacy and locus of control are core self-evaluations, similar to self-determination as mediators or moderators in research (Gielnik et al., 2020). The theory of planned behavior predicts learners' entrepreneurship-related behaviors by analyzing intention: the higher

intention, the more potential to start a business. In detail, learners with positive attitudes, a supportive subjective norm, and strong perceived behavioral control are definitely possible to create a venture, interpreting with psychological and behavioral variables (Bosnjak et al., 2020; Ferreira et al., 2012; Gieure et al., 2019). Entrepreneurship educators adopt Kolb's experiential learning theory (Heinonen & Poikkijoki, 2006), the theory of effectuation (Sarasvathy, 2001), and the lean startup (Reis, 2011) to support learners' starting a real business from zero to one. By learning "through" entrepreneurship, learners attend real-world venture-creation activities on basis of the Kolb's experiential learning (Heinonen & Poikkijoki, 2006; Kolb, 2014; Lattacher & Wdowiak, 2020). This experiential learning facilitates participants' experience of the learning process through seeing, touching, and feeling (Cooper et al., 2004). In contrast with goal-driven causal logic, considering affordable loss and the other four principles, effectual logic begins with means and resources in uncertain situations (Dew et al., 2009; Perry et al., 2012). The lean startup with a set of tools takes root in design thinking that originated from designers and is adopted to build entrepreneurship curricula, such as IBM, Google, and Stanford School of Design (Sarooghi et al., 2019). Sandford School of Design designed this thinking to empathize, define, ideate, prototype, and test steps to detail the entrepreneurship process of the creation of products or services (Camacho, 2016). Based on design thinking, the design sprint helps individuals and organizations launch new ideas quickly and efficiently (Banfield et al., 2015).

With the wide execution of the general education for entrepreneurship and innovation in China since 2015, Chinese HEIs and beyond need a myriad of experienced tutors, entrepreneurship infrastructure, appropriate activities/curricula, and other essential resources to achieve learners' learning success (Huang et al., 2020). Sarooghi and his colleagues (2019) mentioned entrepreneurship faculty aversion to risks encourages students to pursue uncertainty, which is less persuasive, compared with experienced entrepreneurs. With regard to entrepreneurship education practice, teachers' business background has two times higher value than those without, surveyed by Ruskovaara and Pihkala (2015). Both teachers' and staff' entrepreneurship competence impact the transformation of an entrepreneurial university (tasks of knowledge transfer and entrepreneurship) (Seikkula-Leino & Salomaa, 2020). Nurturing entrepreneurship

knowledge and mindsets by teacher educators is relatively easy whereas 'through entrepreneurship' is complicated and needs more effort even in Finland where entrepreneurship education develops well (Seikkula-Leino et al., 2015). In China, educators without entrepreneurship theory and practice backgrounds teach entrepreneurial knowledge and guide learners for attending entrepreneurship competitions (Lyu et al., 2021), especially in HEIs located in the middle and western areas where the institutes lack innovative and entrepreneurial environments and graduates who attend the course just want to achieve the major requirements (Sieger et al., 2021). In light of a Chinese top universities survey from both teachers and learners sides, the shortage of rich experience teachers is one of the three least satisfaction indicators (Liu et al., 2020). To break even, online entrepreneurship education is taken into consideration.

2.1.2 Online entrepreneurship education

Entrepreneurship education broke the spatial and temporal limitations via distance teaching and learning, i.e., television education at Ball State University (Kuratko, 1996). Slightly different from distance education appearing in the 19th century, online education developed with the internet invention and its definition scope is narrower. With the development of technology infrastructure and education theory, parts of entrepreneurship education are moved into online or distance environments, namely online entrepreneurship education came into view as a fresh research topic in 2000 (Chen et al., 2021). Online entrepreneurship education mobilizes experienced educators, courses, and other resources to facilitate distributed learners' learning performance and relieve the tense of entrepreneurship resource shortages. Learners acquire entrepreneurial knowledge, skills, and mindset from curricula and activities, contact with distributed attendees, and follow their own learning pace. Online learners assess each other's written homework three or more times as part of course tasks designed by educators (García-Morales et al., 2021). Students can watch recorded lecture videos in case of internet instability and internship because of flexibility (Camargo et al., 2020). Learning content type is distributed into asynchronous and synchronous streams, such as live class, recorded video, audio, reading materials, homework, team projects, one-to-one tutoring, and online office hour. Educators provide devices and activities for creating communication possibilities between

learners and instructors, as well as collaboration and cooperation among teammates through online and face-to-face communication. This narrows the discrepancy between online and offline education. Empirical studies identified the usefulness of online entrepreneurship training programs (Al-Atabi & DeBoer, 2014; Colombelli et al., 2022). And no significant evidence has proven online education is better than offline, especially in basic knowledge and skills of a discipline (Pei & Wu, 2019). Additionally, online education saves energy during the crisis of energy and protects our environment because of less mobility than face-to-face (Versteijlen et al., 2017). Seeing the merits of online learning and teaching, many HEIs and educators embrace the new type of education to fulfill learners' expectations and learning needs (Guerrero et al., 2021; Volery & Lord, 2000).

MOOCs platforms (i.e., Coursera and edX) offer courses for interested learners who can choose degrees (bachelor or master level) and certifications/badge projects. Learners can learn newer knowledge and themes of interest flexibly, compared to traditional schools and universities (Hew & Cheung, 2014). High-ranking HEIs chase the chance to touch the distributed learners who are unaccepted to attend face-to-face courses. The universities extend their national and international influence and this is beneficial to attract appropriate students. Part of those universities, i.e., Sandford and Harvard, move well-known courses from face-to-face context to online and hybrid environments on their own or collaborated MOOCs platforms. It is clear that this transformation happens in a small percentage of universities and positively impacts a minority of learners, because of the high dropout rate and low interaction possibilities (Vorbach et al., 2019). However, each HEI had to move face-to-face to online settings since COVID-19 is a catalyst, facilitating the booming of online entrepreneurship education practice and academic research (Išoraitė & Gulevičiūtė, 2021; Liguori et al., 2021). Each student attended online lectures, discussions, exercises, team collaboration, and exams so online education is not strange for today's students. However, this is a serious challenge for entrepreneurship education participants since the experiential and collaborative learning method, an important one, is complicated to conduct in online settings. Furthermore, online entrepreneurship education educators and policy-makers lack experience in distance teaching and administration, but they have to adapt to the new situation, especially Chinese learners who still attend entrepreneurship education

programs online because of the sudden breakthrough of COVID-19. Thus, educators and tutors from business schools still maintain case studies, guest speakers, and Question & Answer remotely at a German university. Moreover, online education is flexible and supplies formal face-to-face education. However, online learning or teaching competence for educators and learners is still challenging in course design and choosing learning materials, although education digital transformation is not a fresh topic (Jaggars & Xu, 2016). Formal education needs to foster this online learning and teaching competence for participants and stakeholders in the digital age (Boldureanu et al., 2020). Educators and scholarships should continue to stimulate the development of online entrepreneurship pedagogy. Besides entrepreneurship education given by HEIs, the third institutions, i.e., entrepreneurship education and incubator firms with practical experience in venture creation provide entrepreneurship curricula and guidance for universities and colleges that lack entrepreneurship resources and teaching experience. The third parties design learning software or platforms and provide practical entrepreneurship experiences to support starting a business step by step in both face-to-face and online settings. Plus, the third organization with fewer restrictions and is more flexible than traditional universities. This can mitigate the experience shortage of educators and administrators from academic fields.

Assessment and evaluation of entrepreneurship education, especially practical entrepreneurship training programs should be further updated (Babatunde et al., 2021; Pittaway, 2021). Assessment of online entrepreneurship education can start from 1) measurement of entrepreneurial learning objectives, 2) self-assessments, and 3) interaction assessment (Robles & Braathen, 2002). We evaluated and got feedback on the online program from the curriculum design (i.e., a ratio of theory and practice curriculum), teaching (i.e., teaching methods and guidance), and learning aspects (i.e., learning motivation and learning methods). Formative and summative assessments are adopted at the same time before, during, and after the entrepreneurship education programs (Fayolle et al., 2006; Pittaway & Edwards, 2012). Formative assessment detects ongoing learning and supports learner-centered instruction design (Gikandi et al., 2011). Meanwhile, a summative assessment is completed during the last lesson, supplying certifications or grades. This research (Study 4), for example, collects both formative and summative data, as well as quantitative (log data and questionnaire

survey information from both teacher and student sides) and qualitative data (interview, reflection, and Question & Answer). The qualitative assessment is adaptive or personalized scoring without the right answers (Meyer & Zhu, 2013). Tutors and instructors manually evaluate learners' individualized homework and automatically assess standardized answers by using educational technology tools.

Business school students are familiar with team learning methods since this method facilitates students learning from each other and real-world experience so educators as facilitators provide many collaborative opportunities to understand knowledge and master practice skills (Julie Yazici, 2005). The team learning method in an online environment increases belongingness for distributed learners through communication and collaboration on social media. Teammates share their ideas and information through such as emails, discussion boards or forums, and team diaries to understand learning contents, which provides additional connection possibilities for online participants. However, online education hinders the effectiveness of the team or collaborative learning (Anderson, 2004; Dumford & Miller, 2018). For example, learners design a minimal-value product or complete teamwork with distributed teammates whom they never meet in person and the educators have fewer opportunities for support either. "Learning by doing" and other hands-on activities make online entrepreneurship education the least considered by entrepreneurship educators and policymakers (Liguori et al., 2021). The distributed learners need to get adequate support for interaction and communication to increase social presence, teaching presence, and cognitive presence in online learning settings (Swan et al., 2009). At present, virtual reality, augmented reality, AI, and other cutting-edge educational technologies bring new possibilities to entrepreneurship in an online situation.

2.2 Educational technology

Educational technology is "the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources" (AECT, 2004). The irritation of educational technologies is involved with educational psychology, educational theory, and technology development (Kucuk et al., 2013). For example, with the guidance of behaviorism, cognitivism, and constructivism, the combination of educational technologies and

education evolves and the development of instruction design follows.

Academic research, publications, and organizations of educational technology start into view in the 1970s (Zawacki-Richter & Latchem, 2018). Now educational technology is a subject registered in computer science or educational schools at higher education levels. Meanwhile, other educational levels offer educational technology courses for general education and introduce educational technology in daily teaching, learning, and education administration. Because digital literacy which influences individual work and life is one of the basic requirements for 21st-century citizens (Reddy et al., 2020). Scholars reviewed top-tier academic journals to identify the theme shift and key topics for each period. Zawacki-Richter and Latchem (2018) summarized students, learning, tools, and computer as four keywords hitting per paper between 1976 and 2016 in Computer and Education Journal. Students and learning steadily increased during this period whereas tool and computer decreased. Chen et al.(2020) identified topics mentioned prominently in Computer and Education Journal, that is context and collaborative learning (7.49%), E-learning and policy (6.61%), and experiment and methodologies (6.01%). Bond et al. (2019) reviewed key themes of published papers in British Journal of Educational Technology each decade from 1980 to 2018, which shows the trend of educational technology and learner-center philosophy gradually coming into view. Bozkurt (2020) reviewed peer-reviewed publications from 1993 to 2019 and summarized key themes, which found interdisciplinary research being mainstream. The research trends and patterns of educational technology in one leading journal and of all journals are similar: learning, cutting-edge learning tools (i.e., big data, AI, virtual reality, and augmented reality), and learning analytics become hotspots in this area in the past several years.

Educational technology is classified into a “hardware” (technologies and devices) part and a “software” part (educational technology theory and pedagogy theory) (Bozkurt, 2020). Except for focusing on cutting-edge technologies, educators should understand how to use technologies appropriately and understand their application theory in education. The technology acceptance model is a well-known and widely used framework for educators and scholars in the educational technology area. The technology acceptance model reveals the theory beneath users' acceptance or rejection of certain technology. This classic framework simply described perceived ease

of use and perceived usefulness affect actual use, mediated by the intention to use a type of technology (Davis, 1989). A remarkable number of education researchers adopted this model and its variant to explain how to adopt the learning management systems (Fathema et al., 2015), web-based learning (Gong et al., 2004), mobile learning (Al-Emran et al., 2018), social media (Dumpit & Fernandez, 2017), and other learning and teaching technologies (Granić & Marangunić, 2019). This framework also can be used in entrepreneurship education for analyzing online entrepreneurship education and the application of entrepreneurship educational technology.

The application of educational technology, similar to choosing teaching methods or strategies, should be appropriate for such as learning content, learners, teachers, and available software and hardware devices since the classroom is a whole system (Brown, 1992). Instructors are familiar with educational technology in developed countries and most developing areas in higher education, especially after COVID-19 (Carolan et al., 2020). Higher education learners are digital natives and almost all of universities provide computers and the internet for learning and teaching worldwide. There are even totally online HEIs, i.e., open universities worldwide and Minerva University in the United States. Because different types of educational technologies have different functions (Cheung & Slavin, 2013), educators and policymakers need to check their effectiveness carefully on basis of learning objectives and other above mentioned elements. Pioneers saw the technology trend in the delivery of entrepreneurship education such as Knox (2022), Kuratko (2005), and Liguori and Winkler (2020). However, the scholarly research on entrepreneurship educational technology lags behind other educational fields, especially the field of science and pedagogy.

As mentioned in a specific field, entrepreneurship education educators and scholars are not pioneers in terms of the application of educational technology. For example, nine percent (N = 7) of entrepreneurship education and training programs introduced educational technology and tools in the sustainable development (Rashid, 2019). Entrepreneurship and entrepreneurship education educators and scholars notice it since the 2000s with the online development of higher education and a smattering of learners use it well to acquire entrepreneurial knowledge and skills (Liguori & Winkler, 2020). As a later joiner, entrepreneurial educators take a shortcut and they jump into the latest technology and avoid the mistakes others made. However, they lack a solid

technology application foundation, experience, and adaptive theoretical framework, leading to setbacks. Entrepreneurial educators adopt multimedia, such as videos (Jones & English, 2004), audio (Schumann, 2019), ICT (Oliver & Oliver, 2022; Swaramarinda, 2018), cloud (Holinska et al., 2019), and so on. With the research and development of educational technologies, educators and their stakeholders adopt and apply cutting-edge technologies to stimulate innovation transformation in entrepreneurship (Rashid, 2019). Although AI is still fresh in entrepreneurship education, we reviewed eleven studies that used this technology in teaching and learning shown in chapter 4. We found that AI in entrepreneurship education still has space to catch up with other education fields. Compared with other educational fields, entrepreneurship educational technology theory needs to be further progressed by combination with pedagogy and instruction design. Entrepreneurship education educators can use more educational technology in their teaching since online and blended learning will continue to develop in the digital age. Technology can release the work burden for entrepreneurial educators and the appropriate usage of educational technologies can improve students' learning success and engagement. Entrepreneurship educational technology should center on students and their learning, not teachers and their teaching, in respect of the constructivist. Entrepreneurial educators who lack educational theory and educational technology background struggle with the application of educational technology. Their attention is paid to how to teach, not how to learn at that moment. Therefore, more scholars introduce entrepreneurial educational technology, which is an inevitable trend in this field. Other subjects in business schools should seize this opportunity for transformation (Krishnamurthy, 2020).

COVID-19 also brings transformative opportunities for technology application in the entrepreneurship education (Liguori & Winkler, 2020). In entrepreneurship learning management systems, similar to language learning systems, the learning contents and steps can be set in advance. To attract younger learners (under 50 years old), except for website platforms, software designers and educators should design and employ mobile learning management systems (Han & Shin, 2016). But personalized learning management system has not been widely applied by entrepreneurial educators and stakeholders, as seen in Chapter 4. The first study reviewed serious games that simulate real entrepreneurial processes and entertain participants. AI technology supplies

serious games. For example, the Startup Game designed by Ethan Mollick and his colleagues who come from the Warton School automatedly assesses students' projects, based on four self-set criteria. To sum up, educational technology brings a new view and method to entrepreneurship education.

2.3 Entrepreneurship competence

2.3.1 Entrepreneurship competence

"Entrepreneurship" and "competence" have plenty of synonyms in this research situation. Mentioning entrepreneurship, many similar vocabularies, listing as entrepreneurship, entrepreneurial, entrepreneur, venture/business creation, launching/starting/beginning a business, etc., are used by professorships. Ability, aptitude capacity, capability, competency, and skill are similar to the umbrella term, competence (Weinert, 1999). The above-mentioned terminologies are interchanged in this thesis on basis of initial analysis. Entrepreneurship competence is knowledge, skills, and mindsets of "how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited" (Shane & Venkataraman, 2000, p218). It is worth noting that entrepreneurship in this thesis emphasizes competence and skills for new ventures and startups, excluding intrapreneurship.

Because this study emphasizes an organization's appearance and entrepreneurship entry, not growth and strategies, entrepreneurship competence aims to start a business, including identifying opportunities (identifying, evaluating, and exploiting ideas), mobilizing resources, and initiation (Bacigalupo et al., 2016). The detailed classification of entrepreneurship competence is discussed in Study 3. Nascent entrepreneurs are individuals who are "not-yet-up" or run a start-up between three and 42 months (Garcia-Lorenzo et al., 2018; Gartner & Shaver, 2012). Entrepreneurship competence emphasizes identifying and exploiting an opportunity for venture creation. Entrepreneurship education is usually seen as a sub-field in management education (Ratten & Jones, 2021). Entrepreneurship competence is highly relevant to management competence. The former emphasizes the competence of starting a new business or in an existing institution, slightly different from the latter which focuses on running a venture. Would-be entrepreneurs need to master management competence since entrepreneurs as "Jack of all trades" during the entrepreneurial process (Lazear, 2005). Entrepreneurs should handle management problems during venture creation,

especially when the startup exits. It is worth noting that entrepreneurship competence emphasizes opportunity identification and initiation. Although lucrative entrepreneurship opportunities are vital for venture creation, individual personality traits also influence the processes (Eckhardt & Shane, 2003; Gartner, 1988).

With the wide diffusion of entrepreneurship competence, its modes are constructed by scholars and professionals worldwide to set a standard for educators, policymakers, and stakeholders (Lilleväli & Täks, 2017). Reviewing the literature on compositions of entrepreneurship competence discussed from various aspects, we found Entrepreneurship Competence Framework (EntreComp) includes almost every aspect of this competence, used by individuals and organizations from both detailed and general aspects. With the definition of entrepreneurship defined by the European Commission, the framework of entrepreneurship competence was published in the year of 2016 and slightly modified in 2018. The framework is a complicated interpretation that consists of three dimensions, idea and opportunity competence (i.e., opportunity recognition and assessment), mobilizing resources (i.e., capital and human resources), and taking action (i.e., working with others and management). Each competence area is designed as five competencies with 60 threads assessed by eight levels from foundation to expert, shown in Figure 2.2. The research organization, Joint Research Center, will update this EntreComp for the aim of green transition, as well as digitalization.

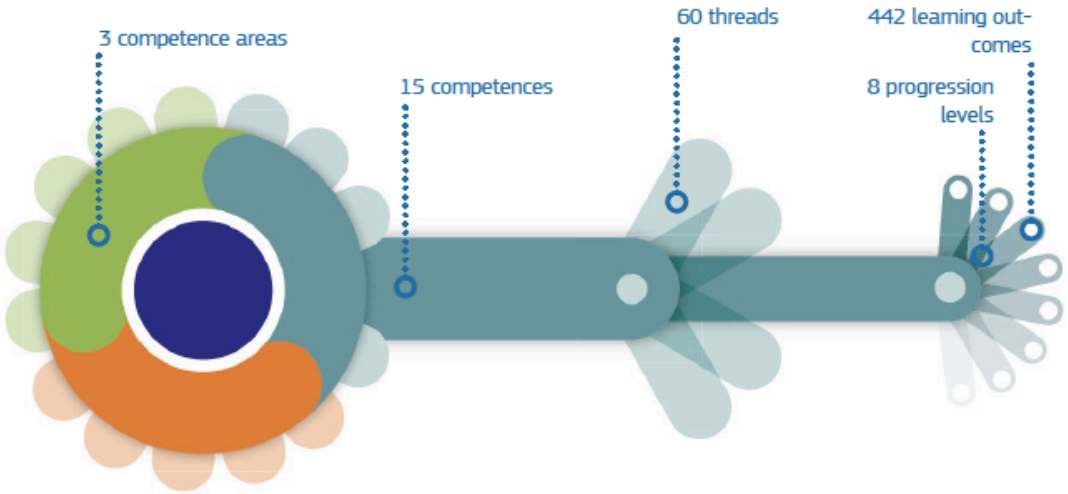

Figure 2-1 Overview of the entrepreneurship competence framework (Cf Bacigalupo et al., 2016)

The three areas with 15 competencies are discussed briefly below. Opportunity identification competence includes three cyclical activities, namely, recognition,

development, and evaluation. The latter two activities are prominent, compared with the idea that entrepreneurial opportunity is made or created by an individual, not existing before entrepreneurs (Ardichvili et al., 2003). In contrast, opportunity discovery relies on technology, industry, and societal changes (i.e., culture, politics, and economics) and entrepreneurs‘ well-developed cognition, pointed out by Schumpeter (Mary George et al., 2016). Although critical, proponents holing opportunity discovery combine would-be entrepreneurs' developed cognition framework with ideas for starting a business (Baron, 2006). Scholars hold multidimensional factors, including exogenous shocks and endogenous actions, namely opportunity creation and opportunity discovery are co-existent (Alvarez & Barney, 2010; Davidsson, 2015; Ramoglou & Tsang, 2016). In detail, entrepreneurs with extensive experience can identify commercial ideas or arbitrage opportunities, then develop and evaluate the ideas by employing their pattern recognition updating during the process (Baron, 2006). Notably, opportunity alertness, itself, is a prerequisite factor in the process of opportunity identification and exploitation (Ardichvili et al., 2003; Kirzner, 2015). Opportunity recognition combines opportunity discovery and creation (Davidsson, 2021).

Opportunity recognition competence contains creativity, vision, valuing ideas, as well as sustainable thinking mentioned in EntreComp. Opportunity evaluation is based on individual knowledge of markets, cognition skills, and learning competence, as well as three types of rule-based learning (Gaglio & Katz, 2001; Wood & Williams, 2014). Prior knowledge (Shane, 2000; Vaghely & Julien, 2010), social networking (Clough et al., 2019), systematic research (Kraus et al., 2017), and personality traits have been systematically reviewed by Mary-George and her colleagues (2016), highly mentioned factors impacting opportunity identification, corresponding to relevant entrepreneurship competence. Opportunity identification is based on would-be entrepreneurs themselves (i.e., cognitive capacities of information processing) and industry trends (i.e., information acquisition), namely, they explore their environment effectively (Gielnik et al., 2014; Schmitt et al., 2018). The strength of social networking positively affects the development of venture creation opportunities, i.e., new opportunities provided by scarce resources (Fuentes et al., 2010). Creativity or innovation is a dichotomy that exists between Schumpeter and Kirzner. That is,

creativity as an indicator tests the quality and quality of ideas of solutions (Karimi et al., 2016) whereas scholars have empirically examined innovation as insignificant for opportunity identification (DeTienne & Chandler, 2004). A clear and shared vision orientates the development of new ventures (Shir & Ryff, 2022). Valuing ideas identifies the financial and social values of ideas of venture creation. Considering the results of entrepreneurial ideas is ethical and sustainable thinking.

Mobilizing resources encompasses entrepreneurs themselves and other resources, such as financial, physical, and social resources from local communities or ecosystems to exploit opportunities (Hertel et al., 2021). Entrepreneurs make use of their own strengths and remedy weaknesses through self-assessment as one indicator of emotional intelligence (Allen et al., 2021; Rhee & White, 2007). Self-efficiency, motivation (Staniewski & Awruk, 2019), and perseverance (Mueller et al., 2017; Nambisan & Baron, 2013) are highly relevant to entrepreneurial performance, where the resource is entrepreneurs per se. Entrepreneurs who believe in themselves and their locus of control retain high motivation for venture creation. Self-efficiency, persistence, and tolerance of ambiguity are emphasized in the (would-be) entrepreneurs (Shane, 2003). Social capital indicates social relationships and their potential resources (Nahapiet & Ghoshal, 1998). Both strong and weak ties benefit opportunity identification, resource mobilization, and legitimacy in the industry (Aldrich & Fiol, 1994; Ardichvili et al., 2003; Stam et al., 2014). From an individual perspective, social capital can be achieved during transactions and social relations. Entrepreneurship needs to accumulate social capital that is affected by business sectors (i.e., business-to-business and business-to-customer service) (Spence et al., 2003). Nascent entrepreneurs should mobilize resources from mutual parties (Villanueva et al., 2012; Clough et al., 2019) and attract talents to the board (Dabić et al., 2011). Financial decisions rely on knowing balance sheets, sales data, etc. (Oseifuah, 2010). Would-be entrepreneurs should know how to attract financial capital from such as business angles, public seed funds, and venture capitalists. For high-tech start-ups, venture capital is a significant method to quench financial shortages. Investors provide capital, management or operation support, and networking for start-ups. Inspiring professionals or human capital needs to be mobilized to identify, discover, or create opportunities through the usage of tacit and explicit knowledge (Davidsson & Honig,

2003). Taking different models of opportunity exploration and exploitation actions is indispensable for would-be entrepreneurs to validate customers and market, starting with the problem/solution fit (Shane & Venkataraman, 2000).

Entrepreneurial ideas promoted by individuals or co-founders transform into behaviors, and during the process, a large of ideas cannot come into action, still keeping in mind or irritated, which is seen in incubators. Psychology, namely entrepreneurship intention and personality traits (especially perceived behavior control), and entrepreneurship education affect behaviors of the venture creation and observable actions (Frese & Gielnik, 2014; Kautonen et al., 2013). Noting that except for individual competence, rates and institutions in a respective context are indispensable for the nature and extent of the entrepreneurial process (Gartner, 1988; Welter, 2011; Williamson, 2000), although they are not research foci in the current study. Here lists the components of EntreComp in the entrepreneurial initiation: entrepreneurs' planning and management, working with others, coping with uncertainty, and learning through experience to launch startups. Planning and management mean goal and priority setting and adapting when initiating a business model. Working with others, that is building teams and collaborating with those who can provide skills founders lack for venture-creating activities (Olugbola, 2017). Risk and uncertainty cannot be calculated concisely, which negatively affects entrepreneurship intention and taking action (Padilla-Meléndez et al., 2014). Uncertainty is a key attribute of entrepreneurial endeavors and entrepreneurs try to mitigate it through new means, ends, and means-ends (Bylund & McCaffrey, 2017; Townsend et al., 2018). Nascent entrepreneurs need to be able to weigh up risks (i.e., financial risks and personal failure risks) and make decisions (Hoogendoorn et al., 2019). However, aversion to risk or risk-taking propensity has been examined as insignificantly different among entrepreneurs (Gartner & Liao, 2012). Learning through experience should reflect previous behaviors and irritate for further actions (Cope, 2011; Shepherd et al., 2019; Sullivan, 2000; Wraae et al., 2021).

In this study occasion, entrepreneurial competence consists of knowledge and skills such as marketing, finance, product design, and management. It is worth noting that entrepreneurship skills instead of entrepreneurship competence in practical teaching and training. Entrepreneurship skills are relevant to design thinking steps where learners launch a product that solves at least one customer pain point. With the

assistance of educators, during the process of design thinking, entrepreneurship learners should gain design thinking mindsets and know how to use design thinking tools (e.g., business model canvas) (Sarooghi et al., 2019). I saved eleven components and distributed them into personality traits and entrepreneurship position, detailed in Study 3.

2.3.2 Digital entrepreneurship competence

Entrepreneurial discovery and exploitation are contextualized and relevant to the location, society, institution, and time (Aldrich, 1990; Prendes-Espinosa et al., 2021). So classic entrepreneurship has different marketing strategies, workplaces, and products and is more bounded and predefined than digital entrepreneurship, which is a generative creation process, low transaction costing, and time-saving to repeatedly test prototype (Ghezzi, 2019; Hair et al., 2012; Kraus et al., 2018). Under digital transformation and the development of digital infrastructure, the digital economy increases drastically and digital entrepreneurship opportunities explore in almost all economic sectors (Hu\djek et al., 2019; Kraus et al., 2018). For example, Web 3 provides decentralization and automatic organization, which changes business models, bringing nascent opportunities for small ventures and individuals (Almeida et al., 2014; Potts & Rennie, 2019). Launching a digital venture, i.e., online production, distribution, and promotion of digital products/services, will produce substantial economic/social benefits and change the entrepreneurial ecosystem (Baig et al., 2022). Therefore, digital entrepreneurship competence is essential for both individuals and organizations, especially for well-educated people with specific professional backgrounds (Qasim et al., 2020; Taatila, 2010). The stages of digital entrepreneurship include idea generation, startup, and entrepreneurial business management (Le Dinh et al., 2018). In practice, Allen (2019) defined digital entrepreneurship skills with eight steps to launch and operate a digital entrepreneurship business prototype in detail.

Scholarships construct digital entrepreneurship competence by combining digital competence and entrepreneurship competence superficially (Ngoasong, 2017; Hu\djek et al., 2019; Ngoasong, 2017). Or they considered digital competence as subordinate to entrepreneurship competence (Kurmanov et al., 2020). Scholars (Erdisna et al., 2022) analyzed four competencies of digital entrepreneurship and the four are mentioned in

entrepreneurship competence as well. It is shown that the difference between digital entrepreneurship competence and entrepreneurship competence is vague. Based on European Union's EntreComp and DigComp framework, the expert and her team constructed a digital entrepreneurship competence framework (EmDigital) (Prendes-Espinosa et al., 2021). Four sections with fifteen sub-competencies and 46 indicators were designed for assessing higher education students' digital entrepreneurship competence (see Figure 2-2). This framework is more scientific and goes further than other current studies

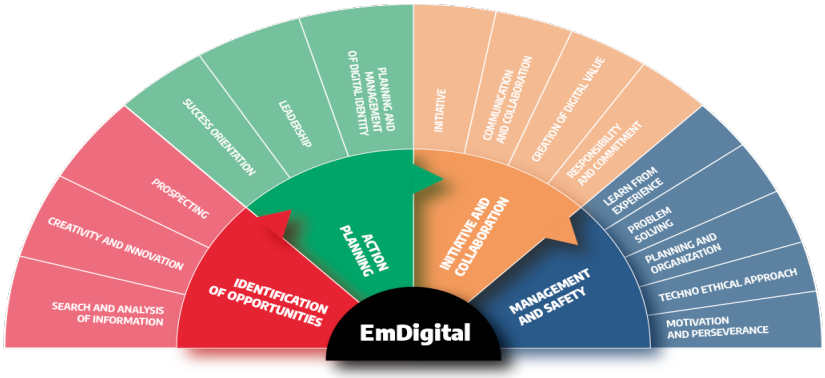

Figure 2-2 Digital Entrepreneurship Competence Framework (Cf. Prendes-Espinosa et al., 2021)

Entrepreneurship takes advantage of cognitions incorporating mental models, intuition, and knowledge structures in entrepreneurship opportunity evaluation, starting a business, and its growth (Mitchell et al., 2002). Following mature ideas, a prototype is designed and launched into a segmented market. The IDEATE (identity, discover, enhance, anticipate, target, and evaluate) model, is a dynamic searching method, specialized search, and analysis of information and prospecting procedure for nascent entrepreneurs (Cohen et al., 2021). Digital entrepreneurs should build one or several digital entrepreneurship identities that are formed by our lives of venture creation on social media and platforms through digital devices (Horst et al., 2020). Online and blended collaboration can reduce environmental pollution and save energy in the entrepreneurship education (Versteijlen et al., 2017). Entrepreneurs should keep good connections with suppliers, competitors, complementors, and customers whereas they should use strong and weak ties to gain social capital and human capital (Davidsson & Honig, 2003), whereas digital entrepreneurs manipulate "internet orchestration" (Wind, 2008). During this survival period, entrepreneurs have fewer management tasks,

compared with mature organizations. To keep existence, the founders should deal with almost everything by themselves or ask other nascent entrepreneurs and they even have no employees yet (Lewis & Churchill, 1983). Therefore, management competence is mainly from individual aspects. From safety aspects, the techno-ethical approach is an important but comparatively less-mentioned section. Digital startups and nascent entrepreneurs should be precautions about users' data and digital property rights, obeying local online security policies (Pisoň, 2020; Tsai et al., 2016)

References

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Al-Atabi, M., & DeBoer, J. (2014). Teaching entrepreneurship using massive open online course (MOOC). Technovation, 34(4), 261–264.

Aldrich, H. E. (1990). Using an ecological perspective to study organizational founding rates. Entrepreneurship Theory and Practice, 14(3), 7–24.

Aldrich, H. E., & Fiol, C. M. (1994). Fools rush in? The institutional context of industry creation. Academy of Management Review, 19(4), 645–670.

Al-Emran, M., Mezhuyev, V., & Kamaludin, A. (2018). Technology Acceptance Model in M-learning context: A systematic review. Computers & Education, 125, 389–412.

Allen, J. P. (2019). Digital entrepreneurship. Routledge.

Allen, J. S., Stevenson, R. M., O'Boyle, E. H., & Seibert, S. (2021). What matters more for entrepreneurship success? A meta-analysis comparing general mental ability and emotional intelligence in entrepreneurial settings. Strategic Entrepreneurship Journal, 15(3), 352–376.

Almeida, F., Santos, J. D., & Monteiro, J. A. (2014). e-commerce business models in the context of web3. 0 paradigm. ArXiv Preprint ArXiv:1401.6102.

Alvarez, S. A., & Barney, J. B. (2010). Entrepreneurship and epistemology: The philosophical underpinnings of the study of entrepreneurial opportunities. Academy of Management Annals, 4(1), 557–583.

Anderson, T. (2004). Teaching in an online learning context. Theory and Practice of Online Learning, 273.

Ardichvili, A., Cardozo, R., & Ray, S. (2003). A theory of entrepreneurial opportunity identification and development. Journal of Business Venturing, 18(1), 105–123.

Babatunde, S., El-Gohary, H., & Edwards, D. (2021). Assessment methods in entrepreneurship education, challenges and opportunities in developed and developing nations: A comparative study of Nigeria and England. Education+ Training.

Bacigalupo, M., Kampylis, P., Punie, Y., & Van den Brande, G. (2016). EntreComp: The entrepreneurship competence framework. Luxembourg: Publication Office of the European Union, 10, 593884.

Baig, U., Hussain, B. M., Meidute-Kavaliauskiene, I., & Davidavicius, S. (2022). Digital Entrepreneurship: Future Research Directions and Opportunities for New Business Model. Sustainability, 14(9), 5004.

Banfield, R., Lombardo, C. T., & Wax, T. (2015). Design sprint: A practical guidebook for building great digital products. O'Reilly Media, Inc.

Barba-Sánchez, V., & Atienza-Sahuquillo, C. (2018). Entrepreneurial intention among engineering students: The role of entrepreneurship education. European Research on Management and Business Economics, 24(1), 53–61.

Baron, R. A. (2006). Opportunity recognition as pattern recognition: How entrepreneurs "connect the dots" to identify new business opportunities. Academy of Management Perspectives, 20(1), 104–119.

Boldureanu, G., Ionescu, A. M., Bercu, A.-M., Bedrule-Grigoruță, M. V., & Boldureanu, D. (2020). Entrepreneurship education through successful entrepreneurial models in higher education institutions. Sustainability, 12(3), 1267.
Bond, M., Zawacki-Richter, O., & Nichols, M. (2019). Revisiting five decades of educational technology research: A content and authorship analysis of the British Journal of Educational Technology. British Journal of Educational Technology, 50(1), 12–63.
Bosnjak, M., Ajzen, I., & Schmidt, P. (2020). The theory of planned behavior: Selected recent advances and applications. Europe's Journal of Psychology, 16(3), 352.
Bozkurt, A. (2020). Educational technology research patterns in the realm of the digital knowledge age. Journal of Interactive Media in Education, 2020(1).
Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. The Journal of the Learning Sciences, 2(2), 141–178.
Brüne, N., & Lutz, E. (2014). The effect of entrepreneurship education in schools on entrepreneurial outcomes: A systematic review. Management Review Quarterly, 70(2), 275–305.
Bylund, P. L., & McCaffrey, M. (2017). A theory of entrepreneurship and institutional uncertainty. Journal of Business Venturing, 32(5), 461–475.
Camacho, M. (2016). David Kelley: From design to design thinking at Stanford and IDEO. She Ji: The Journal of Design, Economics, and Innovation, 2(1), 88–101.
Camargo, C. P., Tempski, P. Z., Busnardo, F. F., Martins, M. de A., & Gemperli, R. (2020). Online learning and COVID-19: A meta-synthesis analysis. Clinics, 75.
Carolan, C., Davies, C. L., Crookes, P., McGhee, S., & Roxburgh, M. (2020). COVID 19: Disruptive impacts and transformative opportunities in undergraduate nurse education. Nurse Education in Practice, 46, 102807.
Casson, M., & Casson, C. (2014). The history of entrepreneurship: Medieval origins of a modern phenomenon. Business History, 56(8), 1223–1242.
Chen, L., Ifenthaler, D., & Yau, J. Y.-K. (2021). Online and blended entrepreneurship education: A systematic review of applied educational technologies. Entrepreneurship Education, 4(2), 191–232.
Chen, X., Zou, D., Cheng, G., & Xie, H. (2020). Detecting latent topics and trends in educational technologies over four decades using structural topic modeling: A retrospective of all volumes of Computers & Education. Computers & Education, 151, 103855.
Cheung, A. C., & Slavin, R. E. (2013). The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis. Educational Research Review, 9, 88–113.
Clough, D. R., Fang, T. P., Vissa, B., & Wu, A. (2019). Turning lead into gold: How do entrepreneurs mobilize resources to exploit opportunities? Academy of Management Annals, 13(1), 240–271.
Cohen, D., Hsu, D. K., & Shinnar, R. S. (2021). Identifying innovative opportunities in the entrepreneurship classroom: A new approach and empirical test. Small Business Economics, 57(4), 1931–1955.
Cohen, S. L., Bingham, C. B., & Hallen, B. L. (2019). The Role of Accelerator Designs in Mitigating Bounded Rationality in New Ventures. ADMINISTRATIVE SCIENCE QUARTERLY, 64(4), 810–854. https://doi.org/10.1177/0001839218782131
Colombelli, A., Panelli, A., & Serraino, F. (2022). A Learning-by-Doing Approach to Entrepreneurship Education: Evidence from a Short Intensive Online International Program. Administrative Sciences, 12(1), 16.
Cooper, S., Bottomley, C., & Gordon, J. (2004). Stepping out of the classroom and up the ladder of learning: An experiential learning approach to entrepreneurship education. Industry and Higher Education, 18(1), 11–22.
Cope, J. (2011). Entrepreneurial learning from failure: An interpretative phenomenological analysis. Journal of Business Venturing, 26(6), 604–623.
Crescenzi, R., Rodriguez-Pose, A., & Storper, M. (2007). The territorial dynamics of innovation: A Europe–United States comparative analysis. Journal of Economic Geography, 7(6), 673–709.

Dabić, M., Ortiz-De-Urbina-Criado, M., & Romero-Martínez, A. M. (2011). Human resource management in entrepreneurial firms: A literature review. International Journal of Manpower, 32(1), 14–33.
Davidsson, P. (2021). Ditching discovery-creation for unified venture creation research. Entrepreneurship Theory and Practice, 10422587211030870.
Davidsson, P., & Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. Journal of Business Venturing, 18(3), 301–331.
Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 319–340.
DeTienne, D. R., & Chandler, G. N. (2004). Opportunity identification and its role in the entrepreneurial classroom: A pedagogical approach and empirical test. Academy of Management Learning & Education, 3(3), 242–257.
Dew, N., Sarasathy, S., Read, S., & Wiltbank, R. (2009). Affordable loss: Behavioral economic aspects of the plunge decision. Strategic Entrepreneurship Journal, 3(2), 105–126.
Dumford, A. D., & Miller, A. L. (2018). Online learning in higher education: Exploring advantages and disadvantages for engagement. Journal of Computing in Higher Education, 30(3), 452–465.
Dumpit, D. Z., & Fernandez, C. J. (2017). Analysis of the use of social media in Higher Education Institutions (HEIs) using the Technology Acceptance Model. International Journal of Educational Technology in Higher Education, 14(1), 1–16.
Eckhardt, J. T., & Shane, S. A. (2003). Opportunities and entrepreneurship. Journal of Management, 29(3), 333–349.
Erdisna, E., Ridwan, M., & Syahputra, H. (2022). Developing Digital Entrepreneurship Learning Model: 4-D Competencies-Based for Millennial Generation in Higher Education. Utamax: Journal of Ultimate Research and Trends in Education, 4(2), 84–100.
Fathema, N., Shannon, D., & Ross, M. (2015). Expanding the Technology Acceptance Model (TAM) to examine faculty use of Learning Management Systems (LMSs) in higher education institutions. Journal of Online Learning & Teaching, 11(2).
Fayolle, A., & Gailly, B. (2015). The impact of entrepreneurship education on entrepreneurial attitudes and intention: Hysteresis and persistence. Journal of Small Business Management, 53(1), 75–93.
Fayolle, A., Gailly, B., & Lassas-Clerc, N. (2006). Assessing the impact of entrepreneurship education programmes: A new methodology. Journal of European Industrial Training.
Fejes, A., Nylund, M., & Wallin, J. (2019). How do teachers interpret and transform entrepreneurship education? Journal of Curriculum Studies, 51(4), 554–566.
Fellnhofer, K. (2019). Toward a taxonomy of entrepreneurship education research literature: A bibliometric mapping and visualization. Educational Research Review, 27, 28–55.
Ferreira, J. J., Raposo, M. L., Rodrigues, R. G., Dinis, A., & Do Paco, A. (2012). A model of entrepreneurial intention: An application of the psychological and behavioral approaches. Journal of Small Business and Enterprise Development, 19(3), 424–440.
Frese, M., & Gielnik, M. M. (2014). The psychology of entrepreneurship. Annual Review of Organizational Psychology and Organizational Behavior, 1(1), 413–438.
Fuentes Fuentes, M. del M., Ruiz Arroyo, M., Bojica, A. M., & Fernández Pérez, V. (2010). Prior knowledge and social networks in the exploitation of entrepreneurial opportunities. International Entrepreneurship and Management Journal, 6, 481–501.
Gaglio, C. M., & Katz, J. A. (2001). The psychological basis of opportunity identification: Entrepreneurial alertness. Small Business Economics, 16, 95–111.
Garcia-Lorenzo, L., Donnelly, P., Sell-Trujillo, L., & Imas, J. M. (2018). Liminal entrepreneuring: The creative practices of nascent necessity entrepreneurs. Organization Studies, 39(2–3), 373–395.

García-Morales, V. J., Garrido-Moreno, A., & Martín-Rojas, R. (2021). The transformation of higher education after the COVID disruption: Emerging challenges in an online learning scenario. Frontiers in Psychology, 12, 616059.
Gartner, W. B. (1988). "Who is an entrepreneur?" is the wrong question. American Journal of Small Business, 12(4), 11–32.
Gartner, W. B., & Shaver, K. G. (2012). Nascent entrepreneurship panel studies: Progress and challenges. Small Business Economics, 39(3), 659–665.
Gartner, W., & Liao, J. (2012). The effects of perceptions of risk, environmental uncertainty, and growth aspirations on new venture creation success. Small Business Economics, 39, 703–712.
Ghezzi, A. (2019). Digital startups and the adoption and implementation of Lean Startup Approaches: Effectuation, Bricolage and Opportunity Creation in practice. Technological Forecasting and Social Change, 146, 945–960.
Gibb, A. (2005). The future of entrepreneurship education–Determining the basis for coherent policy and practice. The Dynamics of Learning Entrepreneurship in a Cross-Cultural University Context, 2(2005), 44–67.
Gielnik, M. M., Bledow, R., & Stark, M. S. (2020). A dynamic account of self-efficacy in entrepreneurship. Journal of Applied Psychology, 105(5), 487.
Gielnik, M. M., Krämer, A.-C., Kappel, B., & Frese, M. (2014). Antecedents of business opportunity identification and innovation: Investigating the interplay of information processing and information acquisition. Applied Psychology, 63(2), 344–381.
Gieure, C., Benavides-Espinosa, M. del M., & Roig-Dobón, S. (2019). Entrepreneurial intentions in an international university environment. International Journal of Entrepreneurial Behavior & Research, 25(8), 1605–1620.
Gikandi, J. W., Morrow, D., & Davis, N. E. (2011). Online formative assessment in higher education: A review of the literature. Computers & Education, 57(4), 2333–2351.
Gong, M., Xu, Y., & Yu, Y. (2004). An enhanced technology acceptance model for web-based learning. Journal of Information Systems Education, 15(4).
Granić, A., & Marangunić, N. (2019). Technology acceptance model in educational context: A systematic literature review. British Journal of Educational Technology, 50(5), 2572–2593.
Guerrero, M., Heaton, S., & Urbano, D. (2021). Building universities' intrapreneurial capabilities in the digital era: The role and impacts of Massive Open Online Courses (MOOCs). Technovation, 99, 102139.
Hägg, G., & Gabrielsson, J. (2019). A systematic literature review of the evolution of pedagogy in entrepreneurial education research. International Journal of Entrepreneurial Behavior & Research.
Hair, N., Wetsch, L. R., Hull, C. E., Perotti, V., & Hung, Y.-T. C. (2012). Market orientation in digital entrepreneurship: Advantages and challenges in a Web 2.0 networked world. International Journal of Innovation and Technology Management, 9(06), 1250045.
Han, I., & Shin, W. S. (2016). The use of a mobile learning management system and academic achievement of online students. Computers & Education, 102, 79–89.
Hébert, R. F., & Link, A. N. (2009). A history of entrepreneurship. Routledge.
Heinonen, J., & Hytti, U. (2010). Back to basics: The role of teaching in developing the entrepreneurial university. The International Journal of Entrepreneurship and Innovation, 11(4), 283–292.
Heinonen, J., & Poikkijoki, S.-A. (2006). An entrepreneurial-directed approach to entrepreneurship education: Mission impossible? Journal of Management Development.
Henry, C., Hill, F., & Leitch, C. (2005). Entrepreneurship education and training: Can entrepreneurship be taught? Part I. Education + Training, 47(2), 98–111. https://doi.org/10.1108/00400910510586524
Hertel, C., Binder, J., & Fauchart, E. (2021). Getting more from many—A framework of community resourcefulness in new venture creation. Journal of Business Venturing, 36(3), 106094.

Hew, K. F., & Cheung, W. S. (2014). Students' and instructors' use of massive open online courses (MOOCs): Motivations and challenges. Educational Research Review, 12, 45–58.
Holinska, T., Komarovska, O., Melnyk, O., Pet'ko, L., Shpitsa, R., Sova, O., & Strohal, T. (2019). Cloud technologies in art entrepreneurship education. Journal of Entrepreneurship Education, 22(5), 1–6.
Hoogendoorn, B., Van der Zwan, P., & Thurik, R. (2019). Sustainable entrepreneurship: The role of perceived barriers and risk. Journal of Business Ethics, 157, 1133–1154.
Horst, S.-O., Järventie-Thesleff, R., & Perez-Latre, F. J. (2020). Entrepreneurial identity development through digital media. Journal of Media Business Studies, 17(2), 87–112.
Huang, Y., An, L., Liu, L., Zhuo, Z., & Wang, P. (2020). Exploring factors link to teachers' competencies in entrepreneurship education. Frontiers in Psychology, 11, 563381.
Hu\djek, I., Širec, K., & Tominc, P. (2019). Digital skills in enterprises according to the European digital entrepreneurship sub-indices: Cross-country empirical evidence. Management: Journal of Contemporary Management Issues, 24(2), 107–119.
Išoraitė, M., & Gulevičiūtė, G. (2021). A study of online entrepreneurship education under conditions of a pandemic. Entrepreneurship and Sustainability Issues, 8(3), 179.
Jaggars, S. S., & Xu, D. (2016). How do online course design features influence student performance? Computers & Education, 95, 270–284.
Jones, C., & English, J. (2004). A contemporary approach to entrepreneurship education. Education+ Training.
Julie Yazici, H. (2005). A study of collaborative learning style and team learning performance. Education+ Training, 47(3), 216–229.
Karimi, S., Biemans, H. J., Lans, T., Aazami, M., & Mulder, M. (2016). Fostering students' competence in identifying business opportunities in entrepreneurship education. Innovations in Education and Teaching International, 53(2), 215–229.
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.
Keeling, R. (2006). The Bologna Process and the Lisbon Research Agenda: The European Commission's expanding role in higher education discourse. European Journal of Education, 41(2), 203–223.
Kirzner, I. M. (1992). Market Process–Essays in the Development of Modern Austrian Economics. London/New York: Routledge.
Kirzner, I. M. (2015). Competition and entrepreneurship. University of Chicago press.
Knox, S. (2022). Fostering student engagement in virtual entrepreneurship education environments. The International Journal of Management Education, 20(3), 100705.
Koh, J. H. L., & Daniel, B. K. (2022). Shifting online during COVID-19: A systematic review of teaching and learning strategies and their outcomes. International Journal of Educational Technology in Higher Education, 19(1), 56. https://doi.org/10.1186/s41239-022-00361-7
Kosslyn, S. M. (2021). Active learning online: Five principles that make online courses come alive. Alinea Learning.
Kraus, S., Niemand, T., Angelsberger, M., Mas-Tur, A., & Roig-Tierno, N. (2017). Antecedents of international opportunity recognition in born global firms. Journal of Promotion Management, 23(3), 386–406.
Kraus, S., Palmer, C., Kailer, N., Kallinger, F. L., & Spitzer, J. (2018). Digital entrepreneurship: A research agenda on new business models for the twenty-first century. International Journal of Entrepreneurial Behavior & Research.
Krishnamurthy, S. (2020). The future of business education: A commentary in the shadow of the Covid-19 pandemic. Journal of Business Research, 117, 1–5.
Kucuk, S., Aydemir, M., Yildirim, G., Arpacik, O., & Goktas, Y. (2013). Educational technology research trends in Turkey from 1990 to 2011. Computers & Education, 68, 42–50. https://doi.org/10.1016/j.compedu.2013.04.016

Kuratko, D. F. (1996). Risk, challenge & innovation: The entrepreneurial experience at Ball State University. American Journal of Business.
Kuratko, D. F. (2005). The emergence of entrepreneurship education: Development, trends, and challenges. Entrepreneurship Theory and Practice, 29(5), 577–597.
Kurmanov, N., Aliyeva, Z., Kabdullina, G., & Mutaliyeva, L. (2020). Digital entrepreneurship competencies among students: Methodological aspects of the maturity level and development program making. Journal of Entrepreneurship Education, 23(2), 1–11.
Le Dinh, T., Vu, M. C., & Ayayi, A. (2018). Towards a living lab for promoting the digital entrepreneurship process. International Journal of Entrepreneurship, 22(1), 1–17.
Lewis, V. L., & Churchill, N. C. (1983). The five stages of small business growth. University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship.
Liguori, E. W., Winkler, C., Zane, L. J., Muldoon, J., & Winkel, D. (2021). COVID-19 and necessity-based online entrepreneurship education at US community colleges. Journal of Small Business and Enterprise Development, 28(6), 821–830.
Liguori, E., & Winkler, C. (2020). From offline to online: Challenges and opportunities for entrepreneurship education following the COVID-19 pandemic. In Entrepreneurship Education and Pedagogy (Vol. 3, Issue 4, pp. 346–351). SAGE Publications Sage CA: Los Angeles, CA.
Lilleväli, U., & Täks, M. (2017). Competence models as a tool for conceptualizing the systematic process of entrepreneurship competence development. Education Research International, 2017.
Liñán, F. (2004). Intention-based models of entrepreneurship education. Piccolla Impresa/Small Business, 3(1), 11–35.
Liu, H., Kulturel-Konak, S., & Konak, A. (2021). Key elements and their roles in entrepreneurship education ecosystem: Comparative review and suggestions for sustainability. Sustainability, 13(19), 10648.
Liu, T., Walley, K., Pugh, G., & Adkins, P. (2020). Entrepreneurship education in China: Evidence from a preliminary scoping study of enterprising tendency in Chinese university students. Journal of Entrepreneurship in Emerging Economies, 12(2), 305–326.
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, 869.
Lyu, J., Shepherd, D. M., & Lee, K. (2021). Teaching entrepreneurship in China: Culture matters. International Journal of Entrepreneurial Behavior & Research, 27(5), 1285–1310.
Maritz, A., Jones, C., & Shwetzer, C. (2015). The status of entrepreneurship education in Australian universities. Education+ Training.
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, 309–350.
McAdam, M., & Marlow, S. (2008). A preliminary investigation into networking activities within the university incubator. International Journal of Entrepreneurial Behavior & Research, 14(4), 219–241.
Meyer, J. P., & Zhu, S. (2013). Fair and equitable measurement of student learning in MOOCs: An introduction to item response theory, scale linking, and score equating. Research & Practice in Assessment, 8, 26–39.
Mitchell, R. K., Busenitz, L., Lant, T., McDougall, P. P., Morse, E. A., & Smith, J. B. (2002). Toward a theory of entrepreneurial cognition: Rethinking the people side of entrepreneurship research. Entrepreneurship Theory and Practice, 27(2), 93–104.
Mueller, B. A., Wolfe, M. T., & Syed, I. (2017). Passion and grit: An exploration of the pathways leading to venture success. Journal of Business Venturing, 32(3), 260–279.
Nabi, G., Liñán, F., Fayolle, A., Krueger, N., & Walmsley, A. (2017). The impact of entrepreneurship education in higher education: A systematic review and research agenda. Academy of Management Learning & Education, 16(2), 277–299.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. Academy of Management Review, 23(2), 242–266.
Nambisan, S., & Baron, R. A. (2013). Entrepreneurship in innovation ecosystems: Entrepreneurs' self–regulatory processes and their implications for new venture success. Entrepreneurship Theory and Practice, 37(5), 1071–1097.
Ngoasong, M. Z. (2017). Digital entrepreneurship in a resource-scarce context: A focus on entrepreneurial digital competencies. Journal of Small Business and Enterprise Development.
Oliver, P. G., & Oliver, S. (2022). Innovative online learning in entrepreneurship education: The impact of embedding real-life industry practice in the virtual learning environment. Industry and Higher Education, 36(6), 756–767.
Olugbola, S. A. (2017). Exploring entrepreneurial readiness of youth and startup success components: Entrepreneurship training as a moderator. Journal of Innovation & Knowledge, 2(3), 155–171.
Oosterbeek, H., Van Praag, M., & Ijsselstein, A. (2010). The impact of entrepreneurship education on entrepreneurship skills and motivation. European Economic Review, 54(3), 442–454.
Padilla-Meléndez, A., Fernández-Gámez, M. A., & Molina-Gómez, J. (2014). Feeling the risks: Effects of the development of emotional competences with outdoor training on the entrepreneurial intent of university students. International Entrepreneurship and Management Journal, 10, 861–884.
Pei, L., & Wu, H. (2019). Does online learning work better than offline learning in undergraduate medical education? A systematic review and meta-analysis. Medical Education Online, 24(1), 1666538.
Perry, J. T., Chandler, G. N., & Markova, G. (2012). Entrepreneurial effectuation: A review and suggestions for future research. Entrepreneurship Theory and Practice, 36(4), 837–861.
Pisoň, Z. (2020). The Future of Tech Startups in Central & Eastern Europe. Bratislava: GLOBSEC Policy Institute. Retrieved from https://www. globsec ….
Pittaway, L. (2021). Entrepreneurship Education in Higher Education: A Review of the US Context. Available at SSRN 3942514.
Pittaway, L., & Cope, J. (2007). Entrepreneurship education: A systematic review of the evidence. International Small Business Journal, 25(5), 479–510.
Pittaway, L., & Edwards, C. (2012). Assessment: Examining practice in entrepreneurship education. Education+ Training.
Potter, J. (2008). Entrepreneurship and higher education: Future policy directions.
Potts, J., & Rennie, E. (2019). Web3 and the creative industries: How blockchains are reshaping business models. In A research agenda for creative industries (pp. 93–111). Edward Elgar Publishing.
Prendes-Espinosa, P., Solano-Fernández, I. M., & García-Tudela, P. A. (2021). EmDigital to promote digital entrepreneurship: The relation with open innovation. Journal of Open Innovation: Technology, Market, and Complexity, 7(1), 63.
Qasim, D., Bany Mohammed, A., & Liñán, F. (2020). The Theoretical Basis of Relevant E-Entrepreneurship Results: A Systematic Literature Review. International Journal of Entrepreneurship and Small Business, 1–30.
Ramoglou, S., & Tsang, E. W. (2016). A realist perspective of entrepreneurship: Opportunities as propensities. Academy of Management Review, 41(3), 410–434.
Rashid, L. (2019). Entrepreneurship education and sustainable development goals: A literature review and a closer look at fragile states and technology-enabled approaches. Sustainability, 11(19), 5343.
Ratten, V., & Jones, P. (2021). Entrepreneurship and management education: Exploring trends and gaps. The International Journal of Management Education, 19(1), 100431.
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.

Reddy, P., Sharma, B., & Chaudhary, K. (2020). Digital literacy: A review of literature. International Journal of Technoethics (IJT), 11(2), 65–94.
Reis, E. (2011). The lean startup. New York: Crown Business, 27, 2016–2020.
Rhee, K. S., & White, R. J. (2007). The emotional intelligence of entrepreneurs. Journal of Small Business & Entrepreneurship, 20(4), 409–425.
Robles, M., & Braathen, S. (2002). Online assessment techniques. Delta Pi Epsilon Journal, 44(1), 39–49.
Ruskovaara, E., & Pihkala, T. (2015). Entrepreneurship education in schools: Empirical evidence on the teacher's role. The Journal of Educational Research, 108(3), 236–249.
Sánchez, J. C. (2013). The impact of an entrepreneurship education program on entrepreneurial competencies and intention. Journal of Small Business Management, 51(3), 447–465.
Saptono, A., & Najah, S. (2018). Development of an assessment instrument of affective domain for entrepreneurship in senior high school. Journal of Entrepreneurship Education, 21(4), 1–12.
Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. Academy of Management Review, 26(2), 243–263.
Sarooghi, H., Sunny, S., Hornsby, J., & Fernhaber, S. (2019). Design thinking and entrepreneurship education: Where are we, and what are the possibilities? Journal of Small Business Management, 57, 78–93.
Schmitt, A., Rosing, K., Zhang, S. X., & Leatherbee, M. (2018). A dynamic model of entrepreneurial uncertainty and business opportunity identification: Exploration as a mediator and entrepreneurial self-efficacy as a moderator. Entrepreneurship Theory and Practice, 42(6), 835–859.
Schumann, H. O. (2019). The use of student-copresented virtual guest speakers in entrepreneurial education. Journal of Education for Business, 94(6), 418–422.
Schumpeter, J., & Backhaus, U. (2003). The theory of economic development. Springer.
Seikkula-Leino, J., & Salomaa, M. (2020). Entrepreneurial competencies and organisational change—Assessing entrepreneurial staff competencies within higher education institutions. Sustainability, 12(18), 7323.
Seikkula-Leino, J., Satuvuori, T., Ruskovaara, E., & Hannula, H. (2015). How do Finnish teacher educators implement entrepreneurship education? Education+ Training.
Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. Organization Science, 11(4), 448–469.
Shane, S. A. (2003). A general theory of entrepreneurship: The individual-opportunity nexus. Edward Elgar Publishing.
Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. Academy of Management Review, 25(1), 217–226.
Shepherd, D. A., Wennberg, K., Suddaby, R., & Wiklund, J. (2019). What are we explaining? A review and agenda on initiating, engaging, performing, and contextualizing entrepreneurship. Journal of Management, 45(1), 159–196.
Shir, N., & Ryff, C. D. (2022). Entrepreneurship, self-organization, and eudaimonic well-being: A dynamic approach. Entrepreneurship Theory and Practice, 46(6), 1658–1684.
Sieger, P., Zellweger, T., Fueglistaller, U., & Hatak, I. (2021). Global Student Entrepreneurship 2021: Insights From 58 Countries (2021 GUESSS GLobal Report).
Spence, L. J., Schmidpeter, R., & Habisch, A. (2003). Assessing social capital: Small and medium sized enterprises in Germany and the UK. Journal of Business Ethics, 47, 17–29.
Stam, W., Arzlanian, S., & Elfring, T. (2014). Social capital of entrepreneurs and small firm performance: A meta-analysis of contextual and methodological moderators. Journal of Business Venturing, 29(1), 152–173.
Staniewski, M. W., & Awruk, K. (2019). Entrepreneurial success and achievement motivation–A preliminary report on a validation study of the questionnaire of entrepreneurial success. Journal of Business Research, 101, 433–440.

Sullivan, R. (2000). Entrepreneurial learning and mentoring. International Journal of Entrepreneurial Behavior & Research, 6(3), 160–175.
Swan, K., Garrison, D. R., & Richardson, J. C. (2009). A constructivist approach to online learning: The community of inquiry framework. In Information technology and constructivism in higher education: Progressive learning frameworks (pp. 43–57). IGI global.
Swaramarinda, D. R. (2018). The usefulness of information and communication technology in entrepreneurship subject. Journal of Entrepreneurship Education, 21(3), 1–10.
Taatila, V. P. (2010). Learning entrepreneurship in higher education. Education+ Training.
Townsend, D. M., Hunt, R. A., McMullen, J. S., & Sarasvathy, S. D. (2018). Uncertainty, knowledge problems, and entrepreneurial action. Academy of Management Annals, 12(2), 659–687.
Tracey, P., & Phillips, N. (2011). Entrepreneurship in emerging markets: Strategies for new venture creation in uncertain institutional contexts. Management International Review, 51, 23–39.
Tsai, H. S., Jiang, M., Alhabash, S., LaRose, R., Rifon, N. J., & Cotten, S. R. (2016). Understanding online safety behaviors: A protection motivation theory perspective. Computers & Security, 59, 138–150.
Turner, T., & Gianiodis, P. (2018). Entrepreneurship unleashed: Understanding entrepreneurial education outside of the business school. Journal of Small Business Management, 56(1), 131–149.
Unger, J. M., Rauch, A., Frese, M., & Rosenbusch, N. (2011). Human capital and entrepreneurial success: A meta-analytical review. Journal of Business Venturing, 26(3), 341–358.
Vaghely, I. P., & Julien, P.-A. (2010). Are opportunities recognized or constructed?: An information perspective on entrepreneurial opportunity identification. Journal of Business Venturing, 25(1), 73–86.
Versteijlen, M., Salgado, F. P., Groesbeek, M. J., & Counotte, A. (2017). Pros and cons of online education as a measure to reduce carbon emissions in higher education in the Netherlands. Current Opinion in Environmental Sustainability, 28, 80–89.
Villanueva, J., Van de Ven, A. H., & Sapienza, H. J. (2012). Resource mobilization in entrepreneurial firms. Journal of Business Venturing, 27(1), 19–30.
Volery, T., & Lord, D. (2000). Critical success factors in online education. International Journal of Educational Management.
Vorbach, S., Poandl, E. M., & Korajman, I. (2019). Digital entrepreneurship education: The role of MOOCs. International Journal of Engineering Pedagogy, 9(3).
Wardana, L. W., Narmaditya, B. S., Wibowo, A., Mahendra, A. M., Wibowo, N. A., Harwida, G., & Rohman, A. N. (2020). The impact of entrepreneurship education and students' entrepreneurial mindset: The mediating role of attitude and self-efficacy. Heliyon, 6(9), e04922.
Weiming, L., Chunyan, L., & Xiaohua, D. (2016). Ten years of entrepreneurship education at chinese universities: Evolution, problems, and system building. Chinese Education & Society, 49(3), 198–216.
Weinert, F. E. (1999). Concepts of competence.
Welter, F. (2011). Contextualizing entrepreneurship—Conceptual challenges and ways forward. Entrepreneurship Theory and Practice, 35(1), 165–184.
Williamson, O. E. (2000). The new institutional economics: Taking stock, looking ahead. Journal of Economic Literature, 38(3), 595–613.
Wilson, F., Kickul, J., & Marlino, D. (2007). Gender, entrepreneurial self–efficacy, and entrepreneurial career intentions: Implications for entrepreneurship education. Entrepreneurship Theory and Practice, 31(3), 387–406.
Wind, Y. (2008). A plan to invent the marketing we need today. MIT Sloan Management Review, 49(4), 21–28.
Wood, M. S., & Williams, D. W. (2014). Opportunity evaluation as rule-based decision making. Journal of Management Studies, 51(4), 573–602.

Wraae, B., Tigerstedt, C., & Walmsley, A. (2021). Using reflective videos to enhance entrepreneurial learning. Entrepreneurship Education and Pedagogy, 4(4), 740–761.

Zawacki-Richter, O., & Latchem, C. (2018). Exploring four decades of research in Computers & Education. Computers & Education, 122, 136–152.

3 Online and blended EE: a systematic review of applied educational technologies

3.1 Introduction

The COVID-19 pandemic is a catalyst in the facilitation of online and blended education, especially in HEIs, as higher education in developed countries has been moved online and it will continue to remain online until the pandemic is over. This created an obstacle to the provision of EE as a discipline, which requires students to acquire "learning by doing"--practical competencies and experiences in an authentic setting (Liguori and Winkler, 2020; Kassean et al., 2015; Kurato, 2005;). However, due to the COVID-19, educators need to transfer educational activities on campus into online environments. To make this transition as seamless as possible and ensure that the teaching and learning objectives are met, the emphasis was placed on the utilization of educational technologies in online and blended settings. Although there have been reviews on various technologies that have been applied in business education including a review of social media (Tess, 2013) and a review of serious games (Faria et al., 2009) in this context, as well as a general review of online and blended education (Arbaugh et al., 2009), there have been limited reviews conducted on the utilization and effectiveness of educational technologies in entrepreneurship learning and teaching (Fayolle, 2013; Rashid, 2019). Various reviews of specific technology can be found, for example, Fox et al. (2018) built a criteria framework to review and evaluate serious entrepreneurial games, educational technologies applied to online and blended EE include technology-mediated to an intelligent method, such as computer *aided instruction* (CAI) (Petridou & Sarri, 2011), *information technology* (Nisheva et al., 2009), *virtual and augmented reality* (Sousa, 2019; Tarabasz et al., 2018), *and big data* (Obschonka & Audretsch, 2020). Our review of the articles which utilized technologies in EE encompasses the following: blog (Zayd & Henry 2017; Udosen, 2019), Wikis (Menkhoff & Bengtsson, 2012), Facebook (Chang & Lee, 2013; Ali et al., 2019), digital and non-digital serious games, course management system (Frederick, 2007; Wu et al., 2019) and MOOCs (Vorbach et al., 2019; Resei et al., 2018; Cirulli et al., 2016).

Our research is motivated by first, the lack of a systematic review of how educational technologies have been effectively applied in EE, and second, the lack of information on the new technologies that have already been introduced to existing EE courses. This

systematic review is mainly to provide guidelines for informing decision-makers and educators about the advantages and challenges of the utilization of these technologies for EE and for supporting them in selecting appropriate tools for their courses. The remainder of the paper is divided into the following – a literature review is presented in section 2, our research methodology and questions are presented in section 3, the results of our systematic review are presented in section 4, and thereafter a discussion and implications of this research in section 5 followed by the conclusion in section 6.

3.2 Literature review

A number of authors have presented research studies on entrepreneurship intention (such as Bae et al., 2014) and Ngoc Khuong and Huu An (2016)) and their implication (such as Henry et al. (2005) and Oosterbeek et al. (2010); however, research studies on educational technologies in EE have been limited despite the practical development and presentation of EE courses using online and blended the internet and technology tools since the last twenty years. Currently, technologies such as Web 2.0, cloud computing, and AI have been utilized for supporting blended and online entrepreneurship teaching and learning. Student management and response systems (e.g., Moodle and Business Operation Support System) have been employed to support learning and teaching as well as collect and analyze learning behavior data. Devices such as laptop or tablet computers, mobile devices, and smartphones are used as a medium for learning and teaching entrepreneurial knowledge, skills, and mindsets. Many studies have been presented, which adopted different technologies in online and blended EE such as Web 2.0 (Jones and Iredale, 2009), cloud computing (Holinska et al., 2019; Ratten, 2013), digital technology (Rippa, 2018), MOOCs (Vorbach et al., 2019; Resei et al., 2018; Cirulli et al., 2016, Al-atabi and Deboer, 2014; Chang, 2017), social media (Waghid, 2017; Chang and Lee, 2013; Ali et al., 2018) and serious games (Romero and Usart, 2013; Protopsaltis et al., 2014). The last three mentioned technologies have been broadly (in relative terms) adopted in online and blended EE. Educators typically adopt more than one technology for the implementation of their EE courses such as Facebook as the type of social media utilized on Moodle 2.0 as the learning management system. An EE course combining serious games within a learning platform has been presented by Protopsaltis et al. (2013) and one combining serious games with social media has been studied by Wu and Song (2019). In order to compare

the different combinations of technologies deployed in EE courses, its definition needs to be specified, which is detailed in the next section.

3.2.1 EE

EE is rarely defined and there is no widely accepted definition (Fayolle,2013). Based on the definitions from Sexton and Bowman (1984), Gibb (2002), Rasmussen and Sørheim (2006), and Liñán (2004), EE is learning and teaching activities, which allow learners to acquire entrepreneurial knowledge, skills, and attitudes necessary for creating and operating a business. The Global Entrepreneurship Index Report 2018 (indicators of the entrepreneurship ecosystem) highlighted that the Global Entrepreneurship Index scores have increased by 3% worldwide (Acs et al., 2018). It showed that North America and European account for 15 occupations in the top 20. The performance of EE presented a similar distribution. Commonly, EE originated from the United States and become a mainstream discipline in business schools as well as other schools in HEIs, partly because innovation is the most consequential characteristic in American culture, education, and society, which meets the requirements of EE (Brooks et al., 2019). The various existing welfare systems and cultures might make entrepreneurship and EE in Europe lag behind that of the United States (Potter et al., 2008; Karimi and Chizari, 2010). The European Commission built an entrepreneurship competence framework containing three competence areas and 15 specific competencies to guide entrepreneurial academics and actions (Bacigalupo et al., 2016). Australia ranked first in the Asia-pacific area in the 2018 report and offered 584 entrepreneurship subjects in 2015 (Maritz et al., 2015). 70% of Malaysian HEIs have built entrepreneurship incubators and they offered entrepreneurship activities in almost every university (Cheng et al., 2009; Rahim et al., 2015). Chinese Ministry of Education takes the entrepreneurial course as a general and compulsory course in HEIs.

EE plays an important role at the different stages of education; however, current EE activities and academic studies are typically available and popular in HEIs (or business and management schools) as under-, post-graduate degrees or Master of Business Administration (MBA). Many researchers attempt to answer “Why,” “How,” “What,” “Who,” “When,” (von Graevenitz et al., 2010; Lackeus, 2015) and “Where” questions related this field (Potter et al., 2008; Karimi and Chizari, 2010; Zhou and Xu, 2012) . A number of empirical studies of EE have been conducted including Fox et al. (2018) and Wu et al. (2018) as well as meta-analyses conducted by Martin et al. (2013), Schlaegel

and Koenig (2012), and Bae et al. (2014). These studies were conducted from a variety of disciplines such as business, education, engineering, and computer science.

3.2.2 Educational technologies deployed in EE

The definition of educational technology has been discussed in Chapter 2. As the routine of pedagogy of EE is from teacher-led to student-centered (Robinson et al., 2016) and the constructivism (Löbler, 2006), the tendency of educational technologies changes from teaching design to learning environments (Januszewski & Molenda, 2013). Namely, the key objective of entrepreneurial educational technologies is to facilitate active, intentional, constructive, and collaborative learning.

Many different but similar concepts of learning environments were utilized, for example, Moore et al. (2010) argued that the analysis of various ingredients of learning environment was essential. According to the percentage of technologies used in education, 30% to 79% consisted of blended courses and 80+% consisted of online ones (Allen & Seaman, 2008). Siemens and Tittenberger (2009) noted that EE utilized additionally augmented technology extending the classroom, blended, and online learning approaches. Watson (2008) argued that blended learning was a connection between F2F and online learning. Online learning is considered as the utilization of the Internet and computers to deliver courses. Therefore, the definitions of learning environments have not been unanimously endorsed. When a definition of online and blended learning was required for the application of EE courses, researchers tended to adopt their self-definition in their research (namely, descriptive definition). Bonk and Graham (2004) argued that blended (hybrid) learning was a combination of F2F learning and distributed learning, which is centered on computers or mobile technologies. Course designers adopt both online and F2F activities in a real or virtual classroom through synchronous and asynchronous technologies (Frederick, 2007).

Compared with F2F EE courses, educational technologies are indispensable when students participate in entrepreneurship activities in online and blended entrepreneurial learning environments. Besides, educational technologies bring with the trend that online and blended entrepreneurial courses are becoming one of the main choices for students, educators, and their stakeholders. Furthermore, a large number of applications applied to EE are produced and updated (e.g., Second Life, Facebook, and online forums), because developers customize certain education

technology to meet the needs of stakeholders. While studies of entrepreneurial educational technologies are scattered and systematic reviews on this topic are lacking. Due to time and resource constraints, developers of educational technology focus on one or two technologies, develop and experiment with one system or application (Buzady and Almeida, 2019; Chandra, 2012). Researchers hardly compare the effectiveness of two or three technologies. Besides, educators and learners should understand the advantages and challenges of each potential technology, which is a basis for choosing a suitable one for learning and teaching. Therefore, conducting a systematic review and comparing the educational technologies utilized in EE are essential for combining theory and practice to construct a successful EE course.

3.2.3 The difference between entrepreneurship teaching and learning

Entrepreneurship pedagogy, the effectiveness for sociality, and the economy are the main consideration of the EE (Fayolle, 2008). Concerning entrepreneurship pedagogy, namely entrepreneurship teaching and learning, the two concepts are defined for it to be understood clearly. Here, we analyzed both from the objective, research, method, and evaluation aspects. EE aims at not only increasing the number of start-ups and entrepreneurs but also enhancing the lifelong skills that a graduate needs for undertaking business endeavors or finding an occupation in the future (Jones, 2010). Clearly, entrepreneurship teaching aims to deliver entrepreneurship knowledge, convey entrepreneurship skills and teach students how to start a business (Gibb, 2002). As entrepreneurship learning relates to individuals and their backgrounds, there is a gap between teachers' teaching and learners' learning. Teacher's self-learning and reflection processes affect entrepreneurship teaching (Seikkula-Leino et al., 2010). While factors from the learners'/learning side are more sophisticated, such as their age (Honjo, 2004), education (Barringer et al., 2005), family entrepreneurs (Wadhwa & Aggarwal, 2009), and personality traits (Barkham, 1994).

There are several traditional and non-traditional methods related to EE: lectures, guest speakers, action-based entrepreneurship programs (esp. workshop, study visits, counselling, setting up a business, games and practical training) (Rasmussen & Sørheim, 2006, Hytti & O'Gorman, 2004). In theory, every method is equal to be introduced into the entrepreneurship class. In practice, learner's preferences and experiences affect learning method choice (Fiet, 2001) and instructors' teaching design applied simplified

and generalized entrepreneurship process. However, the authentic entrepreneurship learning environment is vague and complicated since learners learn from practice. The studies of learning are much more than teaching. The top five variances measured in entrepreneurship programs are perceptions, attitude, self-efficacy, entrepreneurial orientation, and creativity, which are related to learners. Studies of "training" only occupied 7% (Huang-Saad et al., 2018). Furthermore, the number of qualified and trained teachers, courses and programs, and teacher activities (Vesper and Gartner, 199; Purzer and Fila, 2016) are less mentioned. In the end, entrepreneurship teaching and learning are different when adopting educational technologies, which we discuss in the "results" and "discussion" sections. To advance the effectiveness and efficiency of EE, basing on the student-centered concept, our scholars, policy-decision makers, and stakeholders need to focus on entrepreneurship learning.

3.3 Research methodology

3.3.1 Research questions

We conducted a systematic review and compared the utilized technologies from three aspects – pedagogy, usability, and technique. Five concrete examples have been selected for analysis and comparison in detail. The research questions are:

Q1: How are serious games, social media, and digital platforms (mainly MOOCs) technologies applied in online and blended EE?

Q2: What are the strengths and weaknesses of serious games, social media, and digital platforms (mainly MOOCs) in online and blended EE?

3.3.2 Procedure of research

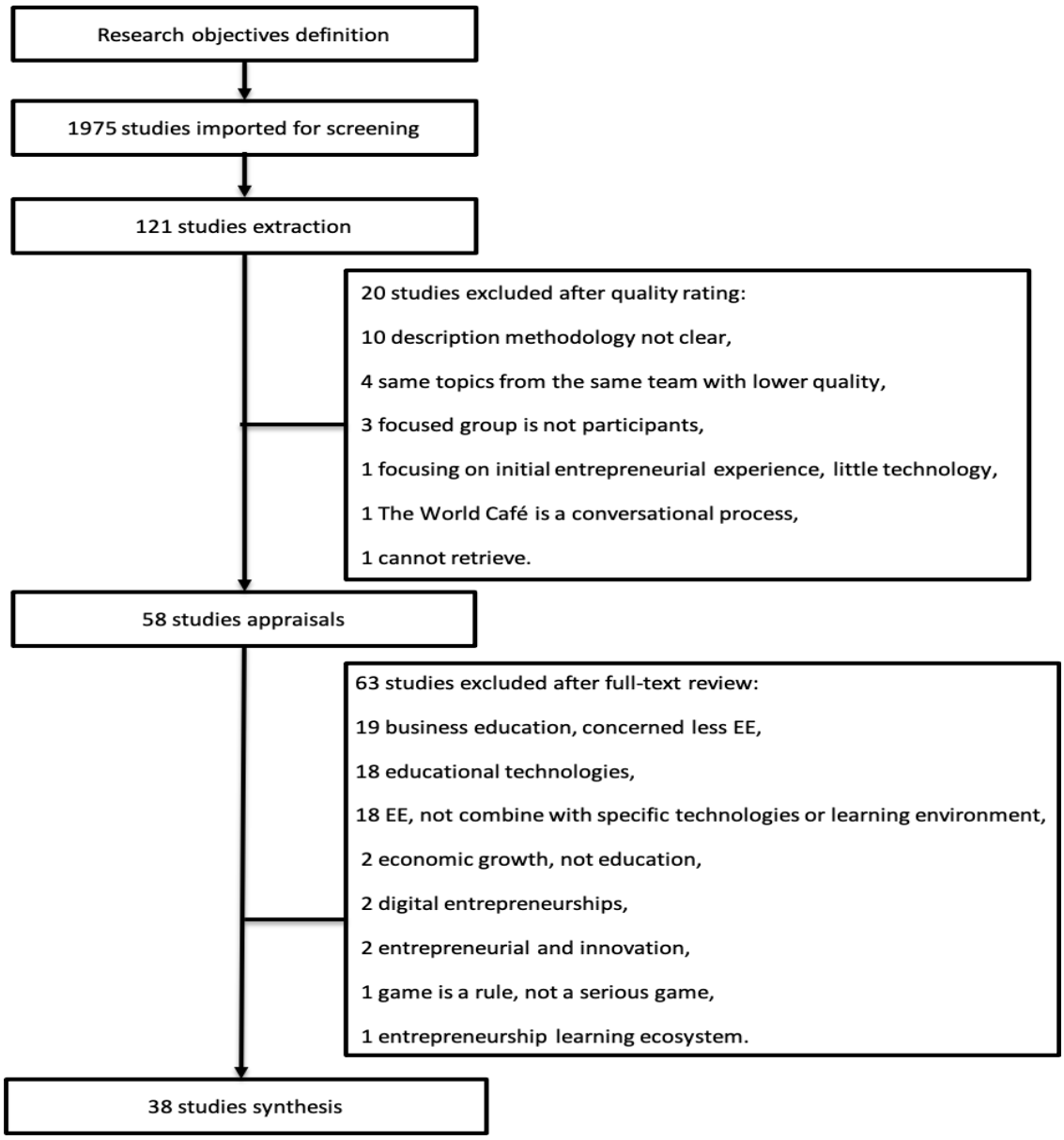

Figure 3-1 Steps of literature collection

The main research objective was to conduct a systematic review, based on Okoli's (2015) eight steps, of the application of educational technologies in online and blended EE. The articles under review were limited to the last twenty years (2000 – 2020) and in the English language. The focus was on "educational technologies" with "entrepreneurial education" and not "technology entrepreneurship", "university incubator", and "technology transfer". The utilized keywords included "entrepreneur* education," "education technology*," "blended," and "online." We searched journals of high impact factor in EE such as Journal of Business Venturing, The Piccola Impresa / Small Business Journal, Education+ Training, Technovation, International Small Business Journal: Researching Entrepreneurship, Academy of Management Learning and

Education, Entrepreneurship Theory and Practice, Journal of Small Business Management and International Entrepreneurship and Management Journal.

We also searched Google Scholar, Web of Science, and ScienceDirect as well as 7 MOOC platforms to collect the description of EE courses. Focusing on technologies in EE such as “distance learning,” “blended learning,” “online learning,” “e-learning,” and “mobile learning” as well as relevant technologies such as “Web 2.0,” “Wiki,” “ICT,” “MOOCs,” “social media,” and “serious games”. The string search combination showed another 121 articles between 2006 and 2020. 61 of the 121 studies were excluded after full-text review due to irrelevance. We conducted a quality appraisal step based on checklists of analyzing research quality (O’Brien et al., 2014; Tong et al., 2007; Mager et al., 2012) with the following quality criterion: the description and appropriateness of clear research questions, sampling selection, data collection, data analysis, and synthesis. The end result was 38 high-quality studies to be analyzed in our systematic review and classified into three categories: social media, serious games, and digital platforms (mainly MOOCs).

3.4 Results of the systematic review

The collected 38 articles were divided into specific adopted technologies: social media (N = 9), serious games (N = 20), and MOOCs (*N* = 9) were listed in Table 3-1. Every study was scrutinized from the definition of EE, the background of the study, methodology, applied technology, focused group, sample, the outcome of EE, and research rigor. The literature was cited 25 times (SD = 28, Min = 1, Max = 133) on average. The studies are scattered in Italy (5), USA (4), Taiwan (4), Malaysia (4), UK (4), Germany (2), Greece (2), Spain (2), Austria (2), Holland (1), Hungary (1), Switzerland (1), Romania (1), South Africa (1), Portugal (1), Ireland (1), Indonesia (1), and Russia (1). Research rigor was measured from the rigor of theory background, method, result, discussion, and conclusion. In terms of research rigor, we rated the articles as strong (N = 3), moderate+ (N = 7), moderate- (N = 20), and weak (N = 8) levels.

Table 3-1 Systematic review applied educational technology in EE

	Reference	Educational technologies	Definition of EE	Context	Focused group	Sample	Method	Expected outcome of EE	Research rigor
Social media	Waghid and Oliver (2017)	Film, blogs and Blackboard	Economic and social development; address social injustices	Social entrepreneurship is not adequately; partially addressed into the curriculum for preservice educators.	A cohort of 3rd-year Bachelor of Education	48	Case study; online group interviews	Sense of social entrepreneurship theory; practical knowledge to help deal with social injustices.	Weak
	Chang and Lee (2013)	Facebook; Moodle 2.0	Encourages students to start their own businesses	to would-be investors. Facebook is commonly used to augment instruction	Students from fourth year elective classes in entrepreneur management	188	Control group experimental study; Questionnaire; Statistics	Knowledge in partner trust and cooperative	Weak
	Ali, et al. (2017)	Facebook	Gives students the exposure in developing their skills and interest in business.	Social networking sites have been issues; the increasing knowing the powerful of social networking to studies; interrupt engagement	Diploma students in the field of engineering/science	400	A cross-sectional survey by using questionnaires to collect data and SPSS to analyze data	take the initiative; develop a business independently; invest with own capitals; business yields profit	moderate
	Swaramarinda (2018)	ICT	No definition	Teachers should be able to apply ICT; the ease of learning process and technology support teaching and learning	Entrepreneurship teachers	102	Descriptive quantitative survey	Entrepreneurship teachers need creative, innovative and productive learning processes	weak
	Menkhoff and Bengtsson (2012)	Wikis; mobile phones	know and understand discuss the challenges	What is often overlooked by university teachers is the potential of these mobile technologies to provide an interesting and enriching learning experience	Undergraduate and instructors	49	Case study	Students were encouraged to expose themselves to interesting locations	Moderate+

	Wu et al. (2018)	PowTo on (web-based ICT)	No definition	ICT is used to traditional teaching methods and competency training	EMBA and MBA	45	quasi-experiment design and qualitative methodology	a business idea	moderate
	Akhmetshi n et al. (2019)	Internet , e-mail; website ;applica tions	Develop core business knowledge and skills; core competencies	distance learning has gained popularity; students still need to attend colleges to take accreditation exams	Distance students and FTF students	5	Case study	Knowledge and skills, competencies	Moderate-
	Josien and Sybrowsky (2013)	eBay	New venture creation; ideas; creating new enterprises and jobs; nurturing the economy	EE has received a lot of attention lately; However, conflicting ways on how and what needs to be taught in such classes have emerged	Undergraduat e entrepreneurs hip students	12	A pre-post-test study	Entrepreneurial skills and aptitude	Weak
	Protopsalti s, et al. (2013)	Serious games and platfor ms	Creative innovation; what factors influenced their success or failure	StartUp_EU	European secondary school students (age 14-18)	47	Pre-post questionnaire survey	Entrepreneurial skills; creating an elevator pitch.	weak
Serio us games	Hauge, et al. (2013)	Serious games	Starting and managing a business	Serious games in higher education are still quite low; A lack of papers describing deployment; critically showing their educational benefits and providing guidelines and practices	Electronic Engineering B.Sc. and, mainly, M.Sc. students.	3 games	a qualitative analysis (case study)	address the field of entrepreneurship (motivation and company management),	moderate
	Bellotti et al. (2012)	Serious games	Personal abilities; new products and services; factor for societies	The lack of a common framework for describing/classifying the educational interventions in a SG	Students ; instructors; entrepreneurs	41;10;5	Interviews and surveys	entrepreneurship attitudes, knowledge and skills	moderate

Bellotti et al. (2014)	Serious games	Personal abilities; new products and services; a key factor for contemporary societies	EE is still relatively immature and rarely adequately addressed in particular in the technical universities,	Higher education engineering students	11	Case study	entrepreneurial mindset	moderate
Antonaci, et al (2015)	Two EE models	how to run a business; knowledge; skills; attitudes	Lifelong Learning Erasmus Fostering Excellence; Innovation in HE (FEXI)	University students	No sample	Case study, build a model to analyze 9 games in 3 universities	knowledge; skills; attitudes	moderate
Fox et al (2018)	Serious games	A complicated education; innovations and variety in teaching methods	There is a void between current theoretical understanding of the entrepreneurship process	Students	8 (games) and 5 (cases)	Systematic literature review; case study	expand knowledge and understanding of educational practice	Strong
Newbery et al. (2016)	Serious games	The process of learning to discover and exploit opportunities	Serious games are playing significant role; Serious games can provide with an authentic learning experience and increasingly taken up by business school	Undergraduate; business and management students	263	A pre-post-test quasi-experiment	Entrepreneurial mindset	Moderate
Mayer et al (2014)	Serious games	Associated with education in other areas	An authentic, experiential didactic that seems particularly appealing to the Net-generation	A master level course in E	28	A quasi-experiment	Enterprising personality, motivation and intentions	Moderate
Buzady and Almeida (2019)	FLIGBY (Serious games)	How to run a business	This approach allows students to understand entrepreneurial activity; not allow students to understand the consequences	Higher education students	18(business course); 31(computer science course)	Case study; quantitative survey	Skills in an immersive way and based on real challenges that can be found in business environments	Moderate

Fellnhofer (2018)	Serious games	Change individuals' attitude towards a career as entrepreneur	There is actually very little experience or proof games as a method for promoting and teaching	EE gamers and gamers	41	Control group experiment and questionnaire survey	Entrepreneurial mindset and start a business	Moderate
Ruiz-Alba et al. (2019)	Serious games	From E aspects, Entrepreneurship is to start a business	Gamification and entrepreneurial intentions still lack empirical investigation.	Online courses students	220 respondents	A quantitative research strategy tested before and after gamification experience	Entrepreneurial intentions	Moderate
Williams (2015)	SimVenture	Mindsets; behaviors; capabilities in young people; start ventures	Evaluating the characteristics and features of games without assessing the benefits to students	Undergraduate management students	32	Action research	Skills, attitudes and behaviors	Weak
Chandra and Leenders (2012)	Second Life	No definition	Scant attention for user innovation and user entrepreneurship that take place within the virtual world	Second Life residents	4	Virtual participant observation; interviews	Skills	Moderate
Mennecke et al. (2008)	Second Life and e-learning	Expose students to business and e/commerce concepts; start and run businesses	Second Life (SL) boasts more than 15 million accounts and is marked by the presence of a strong educational community	Graduate students	29	Comparative method	Start and run virtual businesses in a manner quite similar to the way people engage in business	Moderate
Grivokostopoulou et al. (2019)	3D virtual worlds	Boost employment; sustainable development; economic and social development	"Entrepreneurship Action Plan 2020"; the formulation of EE frameworks; challenging domain	Higher education students	86	Pre-post-test using questionnaire	Entrepreneurial mentality, skills and competencies	Moderate
Wu and Song (2019)	Serious games; social media	Differs from that of general subjects. E is	Relevant studies have focused on the use of one or two social media platform; three social	College students and entrepreneurs	458	Questionnaire and interview survey	Motivation; skills; engagement; knowledge	Moderate

			fascinating but challenging	media platforms have been limited					
	Vorbach, et al. (2019)	MOOCs	Designing, launching and running a new business	Parallel to the evolution of academic entrepreneurship; rapid acceleration of digital technologies	Higher education students	40	Questionnaire survey of empirical study	Entrepreneurial attitudes ,entrepreneurship mindset; knowledge	Weak
	Romero and Usart (2013)	Serious games and MOOC	Requires active; engage in activities	Increase the entrepreneurship orientation; MOOCs	Students and adult citizens	76	Case Study	entrepreneurship basics; MetaVals practice knowledge; HotShot Game E competes and skills	moderate
	Resei et al. (2018)	MOOCs	An important area; relevant in times of crisis and economic challenges	Online EE has strongly accelerated in the last two decades by the development of information technologies	Learners	5 platforms	Desk research	Successfully launch a business; international new ventures; developing knowledge and skills	Moderate
MOOCs	Cirulli et al. (2016)	MOOCs	Incorporating businesses; alternative business models	MOOCs are changing the way in which people can access digital knowledge; creating new opportunities	Higher education students	10	Interviews	Behavior; benefits and opportunities for both individuals and organizations	Moderate
	Al-Atabi and Deboer (2014)	MOOCs	Innovation; technological progress, economic growth	Entrepreneurship as a skill and process is increasingly being taught as a part of various university educational projects	Engineering students	80	Questionnaire survey	collaborative learning; opportunity recognition and resource acquisition	Strong
	Solórzano-García and Navío-Marco (2019)	MOOC communities	Tools, skills and resources to develop their projects	Provide them with a learning environment that gives them the opportunity to be social entrepreneurs	Learners	3250	Pioneer social entrepreneurship massive open online learning communities	Start a business	Moderate+

Kakouris (2016)	TeleCC .org	Entrepreneurial learning in educational terms	Entrepreneurial learning leaks into informal, non-academic settings either face to face or online.	Postgraduates and online learners	18(F2F), 22(online)	Questionnaire.	Knowledge; skills, not focus on start a business	Weak
Frederick (2007)	Moodle	Focusing on realization of opportunity on the best way to operate hierarchies	The technology-savvy generation under the motto "Teaching is best done online and learning is best done in the classroom"	Generation Y	No sample	A grounded theory approach	Theory, process and practice, commercialize their ideas	Moderate
Wu et al. (2019)	Mobile-based CRS (ZUVIO)	A key role in pursuing EI to provide a highly qualified entrepreneurial workforce	Traditional CRS may exhibit difficulties; the use of mobile devices and wireless technologies in education was increasingly	Graduate students	22	Qualitatively; reflection learning report; questionnaire survey	Business knowledge; the art of entrepreneurial experience	Strong
Chang (2017)	World Cafe´ forum; BOSS	Practical knowledge related to the establishment of new business ventures	Many teachers involved in entrepreneurial training are now implementing the ''World Cafe´'' strategy to augment traditional classroom discussions	Participants were hoping to start their own business within 3 years	120	Questionnaire survey	Skills (write business plans)	Moderate

A variety of digital technologies in the online and blended environment have been adopted into EE such as cloud computing (Holinska et al., 2019), learning analytics (Toledo et al., 2020), there digital (3D) virtual reality, serious games (Lameras et al., 2015), social media, digital platforms, big data (Secundo et al., 2020; Sousa, 2019) and so on. The emphasis of these works has been on the implementation and lack of appropriate or relevant research on pedagogy and usability. The results of our systematic review showed that the first study on online and blended EE was conducted in 2006 (Arbaugh et al., 2010). Commencing from 2010, entrepreneurial courses have been made available on MOOCs platforms in cooperation with universities and there has been a number of serious games developed by the games industry to enhance EE. Before the pandemic, learners may have still preferred the F2F format compared with the online and blended versions, despite the increased popularity of the latter. However, during the pandemic when the availability of courses was only limited to online, there has been an increased interest in online and blended EE courses.

3.4.1 Social media in EE

Social media is a method of Web 2.0 that places emphasis on the exchange of views with other learners (Jones & Iredale, 2009). A majority of the new generation born in the digital era embrace social networking sites (SNS) and often fill their daily lives with communicating with others via social software, which is perceived as a welcome way of building distributed human interaction. Additionally, college students adopt social media for informal and formal learning (Dabbagh and Kitsantas, 2012), increasing student engagement (Blaschke, 2014) and satisfaction (Barczyk and Duncan, 2012). Most importantly for entrepreneurship learners, one aim of taking an EE course is to build a social network and human relations (Mitchelmore and Rowley, 2013; Man et al., 2002), where participants communicate with each other (e.g., Facebook, Twitter, and WhatsApp) and show their life (e.g., Snap Chat, YouTube, and Instagram) and work experiences (e.g., LinkedIn, Facebook, and ResearchGate) in social media sites and applications. Kaplan and Haenlein (2010) classified social media into two branches: social presence & media richness and self-presentation & self-disclosure. Self-presentation (e.g., personal profiles) is the impressions that other users form on the user. It is one basic function of social media and has a connection with conversation and relationships (Kietzmann et al., 2011). Since this study specially analyzed serious games

which overlaps with the taxonomy of Kaplan and Haenlein (2010), we excluded them in this section and classified papers (N = 9) using social media technologies into four sub-areas: the extent of media richness (namely, low and high) and interaction level (namely, weak and strong), which is shown in Table 3-2.

Table 3-2 Classification of social media in EE by media richness and interaction

		Media richness	
		low	high
Interaction	weak	Collaborative projects (e.g., Wikis, podcast and blog)	Content communities (e.g., YouTube and eBay)
	strong	Forums (e.g., Moodle forums)	Social networking sites and applications (e.g., Facebook, Skype, WhatsApp, and Twitter)

When designing a course, an animated business planning presentation tends to give better and more attractive results than a presentation without animated videos (Wu et al., 2018). Video reflection is a supplement teaching tool for written reflection (Wraae et al., 2020). Based on the benefits of different social media applications, educators introduced text-based, audio-based, and/or video-based versions into students' learning processes. It is noted that schools providing devices were ready to utilize information communication technologies whereas teachers themselves still lack the readiness (Swaramarinda, 2018). In EE, SNS are supplementary technologies for interaction and communication, More specifically, bachelor students used a wiki (Wetpaint) to create and edit e-commerce websites together through brainstorm (Barczyk and Duncan, 2012). Learners can communicate with other learners, entrepreneurs, and entrepreneurship consultants in Facebook and the Facebook community when attending a business planning course (Chang and Lee, 2013). YouTube has been used to post presentation videos in business education (Alon and Herath, 2014). Online students record and upload an elevator pitch video to YouTube in entrepreneurial management opened by Royal Roads University. The website of eBay also works as an experimental learning tool. Students upload their information about goods and consumers bid on the website (Josien and Sybrowsky, 2013). In Internationalization of Entrepreneurial Marketing Education courses, students located in three different countries often met and conducted many of their teamwork activities in a virtual environment through the utilization of Skype, WhatsApp, and other social

media tools (Reid et al., 2018). The Chinese Entrepreneurial and Asian Business Networks course was taught at a Singapore university where learners utilized Mediawiki and SNS to send messages on their mobile devices (Menkhoff and Bengtsson, 2012).

SNS promotes sharing learning materials and resources, i.e., sharing photos on the Flickr site (Menkhoff and Bengtsson, 2012). Also, personalized content service is provided by utilizing social media that facilitates self-regulated learning (McLoughlin and Lee, 2010). Besides, social media usually combine with digital educational platforms (Chang and Lee, 2013; Waghid, 2017), augmented reality (Gupta and Bharadwaj, 2013), or work as a technology-enhanced learning environment (Manca and Ranieri, 2013) to facilitate EE. Since social media are only one type of digital technologies, digital platforms, big data, intelligent applications, digital storytelling, and other digital methodologies are applied to EE together (Secundo et al., 2020; Sousa, 2019). To conclude, as a vital communication method, social media have been used in daily life and workplaces, as well as education scenes. Therefore, users are familiar with social networking tools that are easy to accept and adopt. Social media provides text, audio, and video message and information for online and blended entrepreneurial learners. Instructors and learners consequently have the initiative to choose an appropriate medium. The interaction and connections between learner-learner, instructor-learner, and learner-content increase the benefits of active learning and social capital (Gupta and Bharadwaj, 2013).

3.4.2 Serious games in EE

The idea of serious games lies in the utilization of games and gaming technologies edutainment: not only for entertainment but also education and training (Eck, 2006). In other words, serious games bring learners additional enjoyment (learning by playing or gaming) and simulate different scenarios to enact real-life situations (Susi et al., 2007). Learning entrepreneurial skills via real-life business scenario simulation can avoid and limit real-life risks and damages, reduce the cost when acquiring entrepreneurial skills and competencies. Concerning learning objectives, as opposed to entrepreneurial knowledge (e.g., finance and marketing) (Tasnim, 2013), serious games develop with more attention towards facilitating entrepreneurial mindset, competencies, and behaviors (Fellnhofer, 2015; Williams, 2015), especially in innovation, opportunities

spotting, risk management, and entrepreneurial intention (Almeida, 2017; Buzady and Almeida, 2019; Ruiz-Alba et al., 2019). Based on the demand for experiential entrepreneurial learning (Constanţa-Nicoleta et al., 2015), game designers simulate a real business environment for learners to run a virtual business (Mennecke et al., 2008) and avoid risks in the real world so that the cost and uncertainty of being entrepreneurs decrease. Mayer et al. (2014) narrowed the research subjects into engineering students, which showed gaming experience could significantly influence EE. Furthermore, Bellotti et al. (2014) analyzed the entrepreneurial mindset of engineering students who play serious games. In general, the relationship between serious games and entrepreneurship intention and skills is positive (Buzady and Almeida, 2019; Bellotti et al., 2014; Almeida, 2017; Fellnhofer, 2015; Ruiz-Alba et al., 2019), even long-term positive effectiveness (Kriz & Auchter, 2016). However, the study of Newbery et al. (2016) found a significant negative impact on the authentic learning method, perhaps because students understood the complexity of starting a business (Protopsaltis et al., 2013) or the serious games is too serious with little entertainment (Caserman et al., 2020). Fox et al. (2018) conducted a systematic review of serious games of EE and evaluated games from fidelity, verification, and validation in entrepreneurial learning. They argued that serious games had practical value for authentic learning and should be introduced to learners before learners start a business in the real-life world. However, the real business environment is more ambiguous and lacks nonplayable characters which appear in in-game worlds (Fox et al., 2018), more complex and uncertain than the mimicked virtual business world. Entrepreneurial games still lack complexity, uncertainty, and interactivity at present to avoid life lessons needed to be experienced by entrepreneurs.

Specific serious games have been applied to EE, such as TeamUp, Slogan, and SimVenture. Compared with TeamUp and Slogan, SimVenture is rich and complex for learners (Mayer et al., 2014). These entrepreneurial games are still found: GoVenture Card Game, the Entrepreneur Card Game, GoVenture: Entrepreneur, and Monopoly. Non-digital games are applied in the F2F class, i.e., Monopoly and Slogan. In an online and blended learning environment, digital serious games, e.g., FLIGBY and SimVenture, are growing in popularity at all school levels. Through reviewing the literature, Hot Shot

Business, SimVenture, ENTRExplorer, and FLIGBY attracted much more attention from scholars and educators in the 2010s. Hot Shot Business is a computer-based entrepreneurship game that was developed by Disney and had been dropped from the website. SimVenture (www.simventure.com) has two simulation games: SimVenture Classic and SimVenture Evolution. As a part of undergraduate and postgraduate modules, SimVenture Evolution is applied in ten UK universities and colleges, following the principle of 'learn by doing' (Williams, 2015). ENTRExplorer (https://www.entrexplorer.com/projecto.php) is for immersive entrepreneurs funded by European Commission, simulating a business through 3D and multiplayer. FLIGBY (http://www. Fligby.com) is a web game, especially for leadership learning. Buzady and Almeida (2019) analyzed the function of FLIGBY from 29 indicators, which shows both technical skills and soft skills increased after playing. To adopt an appropriate game, Antonaci et al. (2014) introduced three strategic axes as well as target skills and pedagogy/ usability features for instructors and scholars. Educators adopted several serious games for the different teaching objectives and context at one online EE, such as business plan, a pilot project of the entrepreneurial idea, market, and product analysis, and evaluation of entrepreneurial skills (Sousa, 2019) course. Concerning the amount of applied serious games, Romero and Usart (2013) utilized two games (Meta Vals and Hot Shot Business) to help learners learn entrepreneurship. Bellotti et al. (2014) analyzed three games (pre-, mid-, and post-game) in one-course time. Hence, according to the objectives of online EE and phrase, instructors provide more than one game in class or at home for learners (Antonaci et al., 2014).

Serious games are found in MOOCs platforms to increase experiential learning activities as well (Romero and Usart, 2013). In the web 2.0 learning content management system, each game connects with a specific entrepreneurial task and mini-games are independent of the system (Protopsaltis et al., 2013). Today, serious games simulate a virtual world characterized by avatars and a 3D environment. In a virtual social world, almost every facet imitates real life. For example, gamers start a business, communicate with other avatars, and earn virtual currency in Second Life where they acquire a notion of the entrepreneurial process in an e-commerce course (Mennecke et al., 2008). Whereas establishing too many rules will restrict avatars and lead to low self-

presentation in a virtual world (Kaplan and Haenlein, 2010). In other words, even virtual reality technology or other technologies simulate real business, it is still a simulated process of being an entrepreneur, which is simplified and idealized. In addition, aims and the phase of EE courses are essential considerations for participants to find out the most suitable ones among the present and constantly designed entrepreneurial games. However, we still lack methods and metrics to choose appropriate entrepreneurial serious games. Furthermore, the future trend of serious games will continue to combine with other cutting-edge technologies to simulate starting a business and entertain the process of learning.

3.4.3 Digital platforms in EE

As a digital educational platform, a course management system or student management system restores and manages data such as learning materials, students' performance, and interaction data. The platform facilitates interaction between student-teacher/peer and learning engagement (Wu, 2017). Most online learners have sufficient time to finish EE courses and express ideas freely (Kakouris, 2016). When starting a discussion, the system automatically distributes questions and team leaders in online World Café (Chang, 2017). EE courses on MOOCs platforms are open and free, and many pay a small amount of tuition to get a certificate (e.g., Most courses cost less than 100 euros to get a certificate). Whilst educators and learners can share high-quality learning resources around the world, which is one of the most obvious advantages of digital platforms. Many stellar universities and companies cooperate with MOOCs platforms to upload entrepreneurial courses and resources in the version of text, audio, and video. Almost all of the MOOC platforms consist of on-demand video lectures, playing on a mobile phone, tablet, and other devices, and providing flexible deadlines and self-paced learning (e.g., Udemy). While UNX provided MOOCs (courses are linked with Udemy platform now) for entrepreneurship and community for entrepreneurs or would-be entrepreneurs mainly in Spain, Portugal, and Latin American (Piñuel, 2014), many MOOCs (e.g., Coursera and EdX) platforms set up "entrepreneur or entrepreneurship" sub-model for worldwide learners. Based on the summarization of Baturay (2015) and information on related platforms, seven common MOOCs management platforms provide EE courses and resources throughout the United States

and Europe. The detailed information is shown in Table 3-3 where authors used "entrepreneurship" to collect EE courses until 25th Feb. 2020.

Table 3-3 MOOCs platforms providing entrepreneurship courses

Platform	Learning products	level	Filter criteria	language	
Coursera	Courses (192), Degrees (3), specialization (28), Mastertrack™ Certificate (1)	Beginner (111), Mixed (78), Intermediate (31)	5	31	
EdX	Courses (59), programs (51), certificate (31), MicroMasters programs (15), professional Education (31), Verified (59), XSeries (5)	Introductory (43), Intermediate (19), Advanced (2)	6	English Spanish	It shows availability of these products. Learners easily find the appropriate
Udemy	No given	All levels (1834), Beginner (1204), Intermediate (207), Expert (32)	9	9	Ratings, price need paid or not
Udacity	Free courses (2)	Beginner, Intermediate (2), Advanced	3	English	
Iversity	Courses (2), programs (2)	No given	3	English German	
MiriadaX	Courses (3)	No given	0	English French	
Futurelearn	Courses (39), Degrees (8), career advice (1), partners (1), topics (1)	No given	1	English	

The first three platforms, namely, Coursera, EdX, and Udemy have the majority of online EE courses. To quickly select suitable courses for learners, based on learners' entrepreneurial learning background, platforms set filter criteria for learners to narrow the scope of courses and easily have a suitable start. Since MOOCs are open to learners worldwide, platforms prefer providing English and giving language options as many as possible. Udemy has the largest amount of entrepreneurship learning products and filter criteria, compared with the other six platforms. According to the components of distance EE courses, at present, it mainly contains on-demand videos, reading materials, exercises, discussion forums, tests as well as learning dashboards designed. The content of videos focuses on entrepreneurial knowledge framework and skills as well as interview videos of successful entrepreneurs. To make MOOCs sustainable

development, micro-credentials (acquisition of specific skills) and university credits (Resei et al., 2018) are introduced into MOOCs platforms. Karma, namely digital reputation, is a factor of retention and completion rate related with learners, rewards and interaction (Navío-Marco & Solórzano-García, 2019). MOOCs combine with interaction to reduce high-rate dropout, e.g., badges, forums, and on-campus students invite online learners to join their teams.

Although a large number of courses resource have high enrolment are presented, 5% course completion rate is typical (Jordan, 2014). A high dropout rate may be unsatisfied with previous online learning experience lack of support services (Ifenthaler and Yau, 2020). Skeptics argue that MOOC platforms are lack of F2F communication, frequent feedback (Welsh and Dragusin, 2013), and self-discipline to complete courses (Vorbach et al., 2019; Romero and Usart, 2013). However, MOOCs are still the mainstream method to construct online and blended entrepreneurial courses (esp. cheap, easy to access, sophisticated framework, and established courses). Plus, other educational technologies such as serious games (Solórzano-García and Navío-Marco, 2019; Frederick, 2007) and social media (Romero and Usart, 2013) combine with online and blended education to meet the needs of learners for high-quality online entrepreneurship courses and boost course completion rates on digital platforms. In conclusion, a digital system is a choice for spreading EE. HEIs and corporations uploaded EE courses on platforms for distributed learners to get micro-credentials and degrees relevant to entrepreneurship. Instructors and learners easily access worldwide high-quality EE resources without limitation of time and space. While lack of F2F interaction and communication weakens the effectiveness of EE. Social media and serious games supply forums, lecture videos, and text materials on the digital platform.

3.5 Discussion

As online and blended entrepreneurial educators, learners, and scholars involved, it is necessary to master the advantages and challenges of social media, serious games, digital platforms, and their combination. Nevertheless, reviews of educational technologies in online and blended EE are still lacking, especially a comparison between them, probably because the F2F method of EE has been dominating the trend. Today, for the pandemic, EE has to transfer into an online and blended environment.

Instructors and stakeholders consider educational technologies to facilitate the effectiveness of learning and teaching. Hence, it is time for a systematic review and compares those three technologies mentioned above.

3.5.1 Social media

Social media is a complimentary resource in professional work (Gruzd & Goertzen, 2013), management education as well as EE (Rueda et al., 2017), since potential entrepreneurship connections and social networks are a success factor for future entrepreneurs. In Italian CLabs, social media is the most leveraged one, compared with big data, digital platforms, and other digital technologies (Secundo et al., 2020). Learners share learning materials and resources, complete teamwork collaborating with team members, and discuss questions (Ajjan and Hartshorne, 2008; Mazman and Usluel, 2010), using various ICT such as text, pictures, audio, and video, or a combination. Instructors' effective attendance in social media makes better teaching performance (Gruzd et al., 2018), and accords with "teacher presence" in an online learning environment (Garrison & Anderson, 2003). However, tutors and chatbots will be a more common alternative for timely feedback because of the overload communication tasks (Fryer et al., 2019). The main function of social media is supporting learning and self-managed learning through boosting learner-to-learner and learner-to-teacher interaction, which produces many short-term teams (namely, the aim of the team is mainly for EE and teammates are not active after completing the course) and leads to collaborative learning. Liu et al. (2010) explored the Perceived Variables of the Technology Acceptance Model (TAM) to research students' intention to use an online learning community. There are five factors (trust, mutual influence, conflict, leadership, and cohesion) that impact student knowledge sharing within virtual teams through the synchronous and asynchronous communicational environment (He & Huang, 2017). Developing trust, making learning contracts, and making sure membership role differences (Allan & Lawless, 2003) are necessary for online and blended EE.

Social media with low media richness and weak interaction usually is applied to learn entrepreneurial knowledge. Podcast records short course-related instruction audio for learners' mobile learning. By assigning tasks to each teammate or a team, Wikis content

is created by students with a guideline. SNS with lower media richness frequently cooperates with other social media and users communicate asynchronously. For example, learners asynchronously communicate on forums and exchange materials so that their classmates and subsequent learners can learn from existing communication information. The recordings of communication can be leveraged for learning analytics. Learners' comments on the blog were collected to conduct inductive reasoning and analyze the learning effect. To make the congruence between comments and students' reality, student interviews were added (Waghid & Oliver, 2017). Social networks with strong interaction usually share profiles, information, and ideas, which probably build a personal relationship and human network for starting a business. As an example of strong interaction and high media richness, a Facebook community can improve the learning effects of writing a business plan through increasing understanding of partner trust and cooperative learning (Chang & Lee, 2013). Compared with other social tools (e.g., WhatsApp, Line, and Twitter), Facebook increased learners' participation even in cross-cultural communication. For example, a Facebook page encourages students to post and follow learning tips so that it facilitates external interaction (Divall & Kirwin, 2012). Besides, Facebook is an important teaching instrument but not a unique one (Manca & Ranieri, 2013a). Compared with low rich social media, entrepreneurial learners perceived that Facebook is more popular and effective (Swaramarinda, 2018). However, as reported, Facebook is the fourth most popular social platform for American' youth, compared with YouTube, Instagram, and Snapchat (Anderson & Jiang, 2018). In other words, video social media are increasing. Educators should be open to new social media to consider the application possibility of entrepreneurial pedagogy.

Compared with F2F, educators are difficult to get real-time learning feedback in online and blended learning environments, especially recorded tutorials on MOOCs platforms. With the application of SNS, learners easily communicate with each other and educators. Learning devices easily record and collect learning data of communication, especially plenty of attendees in online learning, which leads to learning analysis that is a technological tendency of the 2020 Horizon report in higher education.

3.5.2 Serious games

Serious games leveraged in EE have the practical experience and theoretical basis. The project of Stimulating Entrepreneurship through Serious Games (eSerious games, 2011-2013) was executed in four universities of three countries (Bellotti et al., 2012). As a member of this project, Mayer et al. (2014) analyzed the function of serious games and factors that determine its contributions at Delft University of Technology through qualitative and quantitative methods. Depending on collecting data, which was produced by gamers from devices, serious games are sensitive to analyzing data of results and updating the functionality to meet the players' requirements and facilitate active learning in time.

Serious games make EE courses more interesting and attractive than traditional lectures. However, this doesn't mean the motivation of starting a business will increase after playing a game, even the motivation of females decreased (Kriz & Auchter, 2016). What cannot be denied is simulating the process of entrepreneurial activities is to identify business opportunities and start-up and marketing strategies (Constanţa-Nicoleta et al., 2015). Simulative games make this process attractive. For example, gamers attend entrepreneurship activities from Second Life which is a simulative business game and they can even use virtual money in virtual life. Educators encourage and purchase an island on a virtual Second Life space for learners to play this game (Mennecke et al., 2008). While many serious games are stiff and rigid to play with. For example, gamers must follow step by step or skip several steps and they are hard to follow their innovative ideas (e.g., Hot Shot Business). Therefore, compared with other video games, simple serious games are not interesting enough and cannot meet their needs. Today, developers have produced more authentic roles in FLIGBY and SimVenture to make games interesting and real, such as 3D, simulated market, and multi-players. Consequently, students can acquire entrepreneurial skills and conduct behaviors more authentically. Educators choose appropriate serious games as teaching tools depending on entrepreneurial teaching objectives and characteristics of games (Antonaci et al., 2015). Also, the application of serious games needs is wider to structure and amend criteria of assessment. Besides, participants and stakeholders pay close attention to technology development directions and trends to apply by serious games.

With the expansion of AI, it has been adopted by serious games (e.g., the virtual game world) to facilitate an immersive and virtual learning environment. Serious games combine with new technologies, MOOC platforms, and social media, which is the near-future scenario. In the virtual game world, players apply social media to their virtual world communication. As an indispensable component in the virtual game world, social media almost instead of F2F communication in a virtual learning environment.

3.5.3 Digital platforms

Learners easily access high-quality entrepreneurial resources, because the collaboration between digital platforms and HEIs makes online EE courses professional and low-cost. In contrast with the huge number of learners, the completion rate of entrepreneurial courses on digital platforms is relatively low. For one reason, the competence of self-regulation learning and the strategies of setting own learning pace are necessary for distributed learners. The other main reason is entrepreneurship competence and mindset are achieved through practical activities and interaction among learners, which digital platforms are still lacking. Consequently, most EE courses provide online discussion forums to supply online interaction and connection. Instructors usually give topics related to the course to discuss and learners post their puzzles, which improves cooperative and collaboration competence and reduces the dropout rate of courses. All participants with accounts and passwords easily log in to the platform and look for existing entrepreneurship learning resources. Instructors set the “introduce yourself” or “know your classmates” section to know basic information about learners. What’s more, instructors appear in the discussion section and their attendance is highlighted (e.g., Coursera). Compared with forums, SNS supports timely contact and feedback. Thereby, digital platforms introduced social media as well, especially in cMOOCs. cMOOCs focus on connection, emphasize social networking, and are based on the philosophy of connectivism (Rodriguez, 2013). Social media being another main learning method in cMOOCs comment and enhance interactions and collaboration among global virtual classmates (Kaplan & Haenlein, 2016). For example, Identifying Entrepreneurial Opportunities open by the University of Maryland on EdX provides an extra social media link for learners to know each other. Serious games are applied to MOOCs, which make for shortcomings of it, such as engagement (Freire et

al., 2014), completion rates and motivation (Borras-Gene et al., 2016). Serious games depend on or are independent of MOOCs platforms. Serious games which have a close connection with MOOCs platforms need to give feedback beyond “global outcomes” (Freire et al., 2014) and trace multi-level assessment and individual actions to collect more detailed learning data. Cooperating with curriculum designers, erious games which are independent of MOOCs platforms build their platforms. Meanwhile, MOOCs platforms provide an entrance or link for players to log in to games.

In summary, with the rapid development of MOOCs in the 2010s, many digital platforms provide entrepreneurship videos, exercises, and learning materials, combined with forums and workshops, which boosts learners' international collaboration (Welsh & Dragusin, 2013) and affects behaviors and skills related with entrepreneurship (Calvo et al., 2019). MOOCs accelerate the accessibility of EE because of flexibility in time and space (Vorbach et al., 2019). Meanwhile, MOOCs platforms provide EE credentials and degrees based on learners’ performance to facilitate completion rate (Resei et al., 2018a). While the low completion rate of MOOCs needs designers of course provide more support services. Hence, MOOCs platforms flexibly harness social media, serious games, and other technologies.

3.5.4 Comparison between the three technologies

The applications of social media, serious games, and digital platforms are comparatively broad in EE. Evaluating and scoring them depends on the usefulness shown in Table 3-4. These quality criteria were based on Nielsen (1993), who classified usefulness into usability and utility. Analyzing technical usability (sub-concept of usability) (Hindle, 2002) consists of easy to master, efficient, and easy to remember, as well as few serious errors and user satisfaction. The utility is whether can address the needs of the user (Nielsen, 1993; Nokelainen, 2006). Pedagogical usability is a sub-topic of utility. The highest got a score of 3, the middle got a score of 2 and the lowest is a score of 1. Social media were classified into Wiki and Facebook. FLIGBY and SimVenture are illustrations of serious games. Coursera is a research example of digital platforms. Our summarizing each criterion, all five educational technologies scored above 30 points. From entrepreneurship learning aspects, compared with social media and MOOCs, serious games simulate authentic business scenarios in which learners learn by doing to

facilitate entrepreneurial motivation, mindset, competence, and participation rate. While serious games got a lower score for lack of systematic design in entrepreneurial knowledge. Whilst Coursera has a good performance in acquiring knowledge. Except for the flexibility of methods, Coursera got the highest score in the teaching area. Partly because learning on digital platforms has large similarity with traditional education which educators have a profound experience of didactics. Social media has the best performance in the interaction and cooperation part. Facebook as a social communication tool easily build relationship amongst distributed users. From technical usability aspects, participants are easy to master social media whereas they need to learn rules to play serious games. Besides, how to use social media is the easiest to remember for users, especially the young generation (namely, Y-generation and Z-generation). However, serious games are the most efficient of the three and their users' satisfaction is the highest, which is consistent with the essence of games. Compared with the high error risk of serious games, MOOCs have few errors, since MOOCs need lower-level technology support than serious games.

Table 3-4 Comparison of three technologies applied in EE

			SOCIAL MEDIA		**SERIOUS GAMES**		**MOOCS**
			Wiki	Facebook	FLGBY	SimVenture	Coursera
PEDAGOGICAL USABILITY	Usability of E learning	E motivation	2	2	3	3	1
		E knowledge	2	2	1	1	3
		E competence	1	2	3	3	1
		E mindset	1	2	3	3	1
		participation	1	2	3	3	1
	Usability of E teaching	Efficient of E guideline	2	2	2	2	3
		Flexibility of E methods	1	1	2	2	1
		Quality of E activities	2	2	2	2	3
		Achievement of objectives	2	2	1	1	3
	Usability of interaction	Tutor-student interaction	2	2	2	2	1
		Students interaction	2	3	2	2	2
		Student-entrepreneur interaction	2	3	1	1	2
TECHNICAL USABILITY	Easy to master		2	2	3	3	2
	Efficient		2	2	1	1	3

Easy to remember	2	2	3	3	1
Few errors	2	2	1	1	3
User satisfaction	2	2	3	3	1

Therefore, social media, serious games, and digital platforms have been the most popular technologies applied to online and blended EE. All three depend on technology devices to store detailed learning and teaching data that are learning analytics objects. Meanwhile, these technologies are incentive to cutting-edge technologies to update themselves. Social media provide tools to share information, do teamwork, and ask and answer questions without being restricted by time and space in EE. Serious games make EE more interesting and attractive as well as games simulate real business and reduce costs. MOOCs provide worldwide, free, or little-payment learning possibilities. Courses combine with social media and serious games to facilitate collaboration and effectiveness. Gamification factors also are added to social media (Wu and Song, 2019).

3.6 Conclusion

Entrepreneurial competence is critical for individual and economic entities. Furthermore, nowadays both in developed countries and developing countries, the knowledge society calls EE in all levels of education, especially in HEIs. Educational technologies accepted by management education have been reviewed in the last two decades worldwide. While educational technologies applied in EE have lacked systematic review, especially in online and blended entrepreneurial learning as well as teaching. The present study aims to systematically review three popular technologies used in EE and evaluate their effectiveness in the online and blended learning environment through a comparative method. Compared with the F2F or traditional learning environment, the online and blended EE breaks time and distance limitations. Online learning is a broad definition, which contains e-learning, distance learning, and mobile learning. Blended learning is a tendency for HEIs and learning corporations. Meanwhile, technological support is provided to promote entrepreneurial learning as well as instruction so that many popular educational technologies came into our view. When collecting literatures, social media, serious games and digital platforms are the most popular adopted educational technologies in EE. For the application of three

educational technologies is broad in instructors and learners, published literature focus on those three technologies more than other technologies.

Considering social media, which prompts interaction with learner-to-learner and learner-to-instructor, it brings with the possibility of online learning, especially ubiquitous learning. Compared with educational technologies described in the Horizon Report 2020, social media is mainly used before and after online EE courses for preview and review, since F2F is still the main method for instruction and active learning in EE. Learning data is restored on a computer or other smart devices, which leads to easier to analyze data using contemporary tools. Instead of application alone, social media is usually accompanied by other technologies. With the development of technologies, it will appear heterogeneous and multi-social media. Serious games make EE more interesting and attractive than courses without them. Whilst games simulate real business and are based on action-orientation, participants learn entrepreneurial motivation, skills, and knowledge from experiential scenarios. Learning objectives, phases of EE courses, and learning status are basic considerations for choosing serious games. Meanwhile, scholars should construct and standardize criteria for choosing entrepreneurial games in EE. Participants choose EE courses on MOOCs platforms which have different traits and advantages. Skeptics argued that MOOCs lack F2F interaction, frequent feedback, and sufficient support services and self-discipline to complete entrepreneurship courses. While digital platforms facilitate the accessibility of EE because of flexibility in time and distance. And providing entrepreneurial credentials and degrees on basis of learners' completion and performance. In light of marking these three educational technologies in online and blended EE, every technology has its own characteristics and appropriate relevant educational scenes.

This study appears to be the first study to compare social media, serious games, and digital platforms used in EE. With the appearance of cutting-edge technologies, educational technologies in EE need to update technologies and consolidate theoretical underpinning (both technologies and pedagogy). One limitation of this research is the lack of data. Although the combination between EE and educational technologies is a potential area, the application still is a fresh and ever-changing domain. With the rapid speed of technology development, technicians are adopting another technology

possibility to develop its application. The other limitation is this study mainly concerns about three relatively mature technologies without other new technologies. For making sure EE and business education more authentic, attractive, convenient, effective, and efficient, a possible further study will focus on the concrete effects of the three technologies with AI to facilitate entrepreneurial competencies in an online and blended learning environment.

References

Acs, Z., Szerb, L., & Autio, E. (2018). The Global Entrepreneurship Index. In Z. Acs, L. Szerb, & E. Autio, Global Entrepreneurship and Development Index 2018 (pp. 19–38). Springer International Publishing. https://doi.org/10.1007/978-3-319-63844-7_3

Ajjan, H., & Hartshorne, R. (2008). Investigating faculty decisions to adopt Web 2.0 technologies: Theory and empirical tests. The Internet and Higher Education, 11(2), 71–80. https://doi.org/10.1016/j.iheduc.2008.05.002

Al-atabi, M., & Deboer, J. (2014). Author ' s personal copy Technovation Teaching entrepreneurship using Massive Open Online Course (MOOC) Author ' s personal copy. 34, 261–264.

Ali, M. M., Hashim, N., & Ibrahim, A. (2018). The evaluations of facebook as an educational technology tools in polytechnic's entrepreneurship courses. Journal of Fundamental and Applied Sciences, 9(6S), 805. https://doi.org/10.4314/jfas.v9i6s.60

Allan, J., & Lawless, N. (2003). Stress caused by on-line collaboration in e-learning: A developing model. Education + Training, 45(8), 564–572. https://doi.org/10.1108/00400910310508955

Allen, I. E. & Seaman, J. (2008). Staying the course: Online Education in the United States, 2008. In Ultrasound in Obstetrics and Gynecology (Vol. 21, Issue 1). https://doi.org/10.1002/uog.35

Almeida, F. L. (2017). Experience with entrepreneurship learning using serious games. Cypriot Journal of Educational Sciences, 12(2), 69–80. https://doi.org/10.18844/cjes.v12i2.1939

Alon, I., & Herath, R. K. (2014). Teaching International Business via Social Media Projects. Journal of Teaching in International Business, 25(1), 44–59. https://doi.org/10.1080/08975930.2013.847814

Anderson, M., & Jiang, J. (n.d.). Teens, Social Media & Technology 2018. 10.

Antonaci, A., Dagnino, F. M., Ott, M., Bellotti, F., Berta, R., De Gloria, A., Lavagnino, E., Romero, M., Usart, M., & Mayer, I. (2015). A gamified collaborative course in entrepreneurship: Focus on objectives and tools. Computers in Human Behavior, 51, 1276–1283. https://doi.org/10.1016/j.chb.2014.11.082

Archer, G. R., & Axe, J. (2010). Social media engages online entrepreneurship students. Cutting-Edge Social Media Approaches to Business Education: Teaching with LinkedIn, Facebook, Twitter, Second Life, and Blogs., 159–177.

Bacigalupo, M., Kampylis,P., P., Punie, Y., & Van den Brande, G. (2016). EntreComp: The entrepreneurship competence framework. Publications Office. https://data.europa.eu/doi/10.2791/593884

Bae, T. J., Qian, S., Miao, C., & Fiet, J. O. (2014). The Relationship Between EE and Entrepreneurial Intentions: A Meta-Analytic Review. Entrepreneurship: Theory and Practice, 38(2), 217–254. https://doi.org/10.1111/etap.12095

Barczyk, C. C., & Duncan, D. G. (2012). Social Networking Media: An Approach for the Teaching of International Business. Journal of Teaching in International Business, 23(2), 98–122. https://doi.org/10.1080/08975930.2012.718703

Barkham, R. J. (1994). Entrepreneurial characteristics and the size of the new firm: A model and an econometric test. Small Business Economics, 6(2), 117–125. https://doi.org/10.1007/BF01065184

Barringer, B. R., Jones, F. F., & Neubaum, D. O. (2005). A quantitative content analysis of the characteristics of rapid-growth firms and their founders. Journal of Business Venturing, 20(5), 663–687. https://doi.org/10.1016/j.jbusvent.2004.03.004

Baturay, M. H. (2015). An Overview of the World of MOOCs. Procedia - Social and Behavioral Sciences, 174, 427–433. https://doi.org/10.1016/j.sbspro.2015.01.685

Bellotti, F., Berta, R., De Gloria, A., Lavagnino, E., Antonaci, A., Dagnino, F., Ott, M., Romero, M., Usart, M., & Mayer, I. S. (2014). Serious games and the development of an entrepreneurial mindset in higher education engineering students. Entertainment Computing, 5(4), 357–366. https://doi.org/10.1016/j.entcom.2014.07.003

Bellotti, F., Berta, R., De Gloria, A., Lavagnino, E., Dagnino, F., Ott, M., Romero, M., Usart, M., & Mayer, I. S. (2012). Designing a course for stimulating entrepreneurship in higher education through serious games. Procedia Computer Science, 15, 174–186. https://doi.org/10.1016/j.procs.2012.10.069

Blaschke, L. M. (2014). Using social media to engage and develop the online learner in self-determined learning. Research in Learning Technology, 22. https://doi.org/10.3402/rlt.v22.21635

Bonk, C. J. & Graham, C. R. (2004). Blended learning systems: Definition, current trends, and future directions. Guangxue Jishu/Optical Technique, 30(6), 717.

Borras-Gene, O., Martiñez-nunez, M., & Fidalgo-Blanco, Á. (2016). New Challenges for the motivation and learning in engineering education using gamification in MOOC. International Journal of Engineering Education, 32(1), 501–512.

Buzady, Z., & Almeida, F. (2019). FLIGBY-A serious game tool to enhance motivation and competencies in entrepreneurship. Informatics, 6(3). https://doi.org/10.3390/informatics6030027

Calvo, S., Morales, A., & Wade, J. (2019). The use of MOOCs in social enterprise education: An evaluation of a North–South collaborative FutureLearn program. Journal of Small Business & Entrepreneurship, 31(3), 201–223. https://doi.org/10.1080/08276331.2018.1453241

Caserman, P., Hoffmann, K., Müller, P., Schaub, M., Straßburg, K., Wiemeyer, J., Bruder, R., & Göbel, S. (2020). Quality criteria for serious games: Serious part, game part, and balance. JMIR Serious games, 8(3), e19037.

Chang, W. L. (2017). Online training for business plan writing through the World Café method: The roles of leadership and trust. Universal Access in the Information Society, 16(2), 313–324. https://doi.org/10.1007/s10209-016-0459-y

Chang, W. L., & Lee, C. Y. (2013). Trust as a learning facilitator that affects students' learning performance in the Facebook community: An investigation in a business planning writing course. Computers and Education, 62, 320–327. https://doi.org/10.1016/j.compedu.2012.11.007

Cirulli, F., Cirulli, F., Elia, G., Lorenzo, G., & Margherita, A. (2016). Knowledge Management & E-Learning application in the technology entrepreneurship field Recommended citation: Application in the technology entrepreneurship field. 8(1), 109–123.

Constanţa-Nicoleta, B., Radu Ioan, M., Maria-Iuliana, D., Augustin, P., Narcisa Georgeta, C. (2015). Simulation-Based E-Learning Framework for EE and Training. Amfiteatru Economic Journal, 17(38), 10–24.

Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. The Internet and Higher Education, 15(1), 3–8. https://doi.org/10.1016/j.iheduc.2011.06.002

Divall, M. V., & Kirwin, J. L. (2012). Using facebook to facilitate course-related discussion between students and faculty members. American Journal of Pharmaceutical Education, 76(2), 1–5. https://doi.org/10.5688/ajpe76232

Eck, R. V. (2006). Digital Game-Based Learning: It's Not Just the Digital Natives Who Are Restless…. 17.

Fayolle, A. (2008). EE AT A CROSSROADS: TOWARDS A MORE MATURE TEACHING FIELD. Journal of Enterprising Culture, 16(04), 325–337. https://doi.org/10.1142/S0218495808000211

Fayolle, A. (2013). Personal views on the future of EE. A Research Agenda for EE, 25(May), 127–138. https://doi.org/10.4337/9781786432919.00013

Fellnhofer, K. (2015). Changing entrepreneurial intention and behaviour: A digital game-based learning environment dedicated to EE. J. for International Business and Entrepreneurship Development, 8(4), 378. https://doi.org/10.1504/jibed.2015.072938

Fiet, J. O. (2001). The theoretical side of teaching entrepreneurship. Journal of Business Venturing, 16(1), 1–24. https://doi.org/10.1016/S0883-9026(99)00041-5

Fox, J., Pittaway, L., Uzuegbunam, I. (2018). Simulations in EE: Serious games and Learning Through Play.pdf (pp. 61–89).

Frederick, H. (2007). Blended learning in EE in the Asia-Pacific: A grounded theory approach to entrepreneurship pedagogy. Deakin Research Online, 1–16.

Freire, M., Del Blanco, Á., & Fernańdez-Manjón, B. (2014). Serious games as edX MOOC activities. IEEE Global Engineering Education Conference, EDUCON, April, 867–871. https://doi.org/10.1109/EDUCON.2014.6826198

Fryer, L. K., Nakao, K., & Thompson, A. (2019). Chatbot learning partners: Connecting learning experiences, interest and competence. Computers in Human Behavior, 93, 279–289. https://doi.org/10.1016/j.chb.2018.12.023

Gibb, A. (2002). In pursuit of a new "enterprise" and "entrepreneurship" paradigm for learning: Creative destruction, new values, new ways of doing things and new combinations of knowledge. International Journal of Management Reviews, 4(3), 233–269. https://doi.org/10.1111/1468-2370.00086

Gruzd, A., Haythornthwaite, C., Paulin, D., Gilbert, S., & del Valle, M. E. (2018). Uses and Gratifications factors for social media use in teaching: Instructors' perspectives. New Media & Society, 20(2), 475–494. https://doi.org/10.1177/1461444816662933

Gupta, N., & Bharadwaj, S. S. (2013). Agility in business school education through richness and reach: A conceptual model. 15.

He, J., & Huang, X. (2017). Collaborative Online Teamwork: Exploring Students' Satisfaction and Attitudes with Google Hangouts as a Supplementary Communication Tool. Journal of Research on Technology in Education, 49(3–4), 149–160. https://doi.org/10.1080/15391523.2017.1327334

Henry, C., Hill, F., & Leitch, C. (2005). EE and training: Can entrepreneurship be taught? Part I. Education and Training, 47(2), 98–111. https://doi.org/10.1108/00400910510586524

Hindle, K. (2002). A Grounded Theory for Teaching Entrepreneurship Using Simulation Games. 6.

Holinska, T., Komarovska, O., Melnyk, O., Pet'ko, L., Shpitsa, R., Sova, O., & Strohal, T. (2019). CLOUD TECHNOLOGIES IN ART EE. 22(5), 6.

Honjo, Y. (2004). Growth of new start-up firms: Evidence from the Japanese manufacturing industry. Applied Economics, 36(4), 343–355. https://doi.org/10.1080/00036840410001674277

Huang-Saad, A. Y., Morton, C. S., & Libarkin, J. C. (2018). Entrepreneurship Assessment in Higher Education: A Research Review for Engineering Education Researchers: Entrepreneurship Assessment in Higher Education. Journal of Engineering Education, 107(2), 263–290. https://doi.org/10.1002/jee.20197

Hytti, U., & O'Gorman, C. (2004). What is "enterprise education"? An analysis of the objectives and methods of enterprise education programmes in four European countries. Education + Training, 46(1), 11–23. https://doi.org/10.1108/00400910410518188

Ifenthaler, D., & Yau, J. Y.-K. (2020). Utilising learning analytics to support study success in higher education: A systematic review. Educational Technology Research and Development, 68(4), 1961–1990. https://doi.org/10.1007/s11423-020-09788-z

Januszewski, A. & Molenda, M. (2013). Educational Technology: A definition with commentary. In Journal of Chemical Information and Modeling (Vol. 53, Issue 9). https://doi.org/10.1017/CBO9781107415324.004

Jones, B., & Iredale, N. (2009a). EE and Web 2.0. Journal of Research in Marketing and Entrepreneurship, 11(1), 66–77. https://doi.org/10.1108/14715200911014158

Jones, B., & Iredale, N. (2009b). EE and Web 2.0. Journal of Research in Marketing and Entrepreneurship, 11(1), 66–77. https://doi.org/10.1108/14715200911014158

Jones, C. (2010). EE: Revisiting our role and its purpose. Journal of Small Business and Enterprise Development, 17(4), 500–513. https://doi.org/10.1108/14626001011088697

Jordan, K. (2014). Initial trends in enrolment and completion of massive open online courses. The International Review of Research in Open and Distributed Learning, 15(1). https://doi.org/10.19173/irrodl.v15i1.1651

Josien, L., Sybrowsky, J. (2013). Teaching entrepreneurship in action: Using Ebay as an enducational tool. Journal of EE, 16(January 2013), 1–11.

Kaplan, A. M., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media. Business Horizons, 53(1), 59–68. https://doi.org/10.1016/j.bushor.2009.09.003

Kaplan, A. M., & Haenlein, M. (2016). Higher education and the digital revolution: About MOOCs, SPOCs, social media, and the Cookie Monster. Business Horizons, 59(4), 441–450. https://doi.org/10.1016/j.bushor.2016.03.008

Karimi, S., & Chizari, M. (2010). EE in Iranian Higher Education: The Current State and Challenges. 16.

Kassean, H., Vanevenhoven, J., Liguori, E., & Winkel, D. E. (2015). EE: A need for reflection, real-world experience and action. International Journal of Entrepreneurial Behavior & Research, 21(5), 690–708. https://doi.org/10.1108/IJEBR-07-2014-0123

Kietzmann, J. H., Hermkens, K., McCarthy, I. P., & Silvestre, B. S. (2011). Social media? Get serious! Understanding the functional building blocks of social media. Business Horizons, 54(3), 241–251. https://doi.org/10.1016/j.bushor.2011.01.005

Kriz, W. C., & Auchter, E. (2016). 10 Years of Evaluation Research Into Gaming Simulation for German Entrepreneurship and a New Study on Its Long-Term Effects. Simulation & Gaming, 47(2), 179–205. https://doi.org/10.1177/1046878116633972

Lameras, P., Tsiatsos, T., Petridis, P., Tolis, D., Liarokapis, F., Anastasiadou, D., Protopsaltis, A., Hendrix, M., & Arnab, S. (2015). Creative thinking experimentations for entrepreneurship with a disruptive, personalised and mobile game-based learning ecosystem. 5.

Liguori, E., & Winkler, C. (2020). From Offline to Online: Challenges and Opportunities for EE Following the COVID-19 Pandemic. EE and Pedagogy, 3(4), 346–351. https://doi.org/10.1177/2515127420916738

Liñán, F. (2004). Intention-based models of EE. Piccola Impresa / Small Business, 2004(3), 11–35.

Liu, I. F., Chen, M. C., Sun, Y. S., Wible, D., & Kuo, C. H. (2010). Extending the TAM model to explore the factors that affect Intention to Use an Online Learning Community. Computers and Education, 54(2), 600–610. https://doi.org/10.1016/j.compedu.2009.09.009

Löbler, H. (2006). Learning entrepreneurship from a constructivist perspective. Technology Analysis & Strategic Management, 18(1), 19–38. https://doi.org/10.1080/09537320500520460

Man, T. W. Y., Lau, T., & Chan, K. F. (2002). The competitiveness of small and medium enterprises A conceptualization with focus on entrepreneurial competencies$. Journal of Business Venturing, 20.

Manca, S., & Ranieri, M. (2013a). Is it a tool suitable for learning? A critical review of the literature on Facebook as a technology-enhanced learning environment. Journal of Computer Assisted Learning, 29(6), 487–504. https://doi.org/10.1111/jcal.12007

Manca, S., & Ranieri, M. (2013b). Is it a tool suitable for learning? A critical review of the literature on Facebook as a technology-enhanced learning environment: Is Facebook a tool suitable for learning? Journal of Computer Assisted Learning, 29(6), 487–504. https://doi.org/10.1111/jcal.12007

Maritz, A., Jones, C., & Shwetzer, C. (2015). The status of EE in Australian universities. Education + Training, 57(8/9), 1020–1035. https://doi.org/10.1108/ET-04-2015-0026

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

Mazman, S. Gu., & Usluel, Y. K. (2010). Modeling educational usage of Facebook. 10.

McLoughlin, C., & Lee, M. J. W. (2010). Personalised and self regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software. Australasian Journal of Educational Technology, 26(1), 28–43. https://doi.org/10.14742/ajet.1100

Menkhoff, T., & Bengtsson, M. L. (2012). Engaging students in higher education through mobile learning: Lessons learnt in a Chinese entrepreneurship course. Educational Research for Policy and Practice, 11(3), 225–242. https://doi.org/10.1007/s10671-011-9123-8

Mennecke, B. E., Mcneill, D., Ganis, M., Roche, E. M., & Bray, D. A. (2008). Supply Chain and Information Systems Publications Supply Chain and Information Systems Second Life and Other Virtual Worlds: A Roadmap for Research. Supply Chain and Information Systems Publications, 3.

Mennecke, B., Hassall, L. M., & Triplett, J. (2008). The mean business of second life: Teaching entrepreneurship, technology and e-commerce in immersive environments. MERLOT Journal of Online Teaching and Learning, 4(3), 339–348.

Mitchelmore, S., & Rowley, J. (2013). Entrepreneurial competencies of women entrepreneurs pursuing business growth. Journal of Small Business and Enterprise Development, 20(1), 125–142. https://doi.org/10.1108/14626001311298448

Moore, J. L., Dickson-Deane, C., & Galyen, K. (2010). E-Learning, online learning, and distance learning environments: Are they the same? Internet and Higher Education, 14(2), 129–135. https://doi.org/10.1016/j.iheduc.2010.10.001

Navío-Marco, J., & Solórzano-García, M. (2019). Student's social e-reputation ("karma") as motivational factor in MOOC learning. Interactive Learning Environments, 1–15. https://doi.org/10.1080/10494820.2019.1579237

Newbery, R., Lean, J., & Moizer, J. (2016). Evaluating the impact of serious games: The effect of gaming on entrepreneurial intent. Information Technology and People, 29(4), 733–749. https://doi.org/10.1108/ITP-05-2015-0111

Ngoc Khuong, M., & Huu An, N. (2016). The Factors Affecting Entrepreneurial Intention of the Students of Vietnam National University—A Mediation Analysis of Perception toward Entrepreneurship. Journal of Economics, Business and Management, 4(2), 104–111. https://doi.org/10.7763/joebm.2016.v4.375

Nielsen, J. (1993). Usability engineering. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 4970 LNCS, 527–554. https://doi.org/10.1007/978-3-540-70552-9_21

Nisheva, M., Gourova, E., & Antonova, A. (2009). ICT and Entrepreneurship Skills at FMI. 8.

Nokelainen. (2006). Interoperability of educational systems—Editorial of special issue. Educational Technology and Society, 9(2), 1–3.

Obschonka, M., & Audretsch, D. B. (2020). Artificial intelligence and big data in entrepreneurship: A new era has begun. Small Business Economics, 55(3), 529–539. https://doi.org/10.1007/s11187-019-00202-4

Oosterbeek, H., van Praag, M., & Ijsselstein, A. (2010). The impact of EE on entrepreneurship skills and motivation. European Economic Review, 54(3), 442–454. https://doi.org/10.1016/j.euroecorev.2009.08.002

Petridou, E., & Sarri, K. (2011). Developing “Potential Entrepreneurs” In Higher Education Institutes. Journal of Enterprising Culture, 19, 79–99.
Potter, J., Local Economic and Employment Development (Program), & Organisation for Economic Co-operation and Development (Eds.). (2008). Entrepreneurship and higher education / edited by Jonathan Potter. Organisation for Economic Co-operation and Development.
Protopsaltis, A., Hainey, T., Borosis, S., Connolly, T., & Copado, J. (2013). StartUP_EU: Using Game-Based Learning and Web 2.0 Technologies to Teach Entrepreneurship to Secondary Education Students. 14.
Protopsaltis, A., Hetzner, S., Borotis, S., Connolly, T., & Hainey, T. (2014). How to teach entrepreneurship using serious games and web 2.0. Proceedings - IEEE 14th International Conference on Advanced Learning Technologies, ICALT 2014, 227–229. https://doi.org/10.1109/ICALT.2014.72
Purzer, E., & Fila, N. (2016). Evaluation Of Current Assessment Methods In -Engineering EE. EE, 27.
Rahim, H. L., Kamaruddin, M., Lajin, N. F. M., Buyong, S. Z., & Bakri, A. A. (2015). EE IN MALAYSIA: A CRITICAL REVIEW. 02(02), 11.
Rashid, L. (2019). EE and Sustainable Development Goals: A literature Review and a Closer Look at Fragile States and Technology-Enabled Approaches. Sustainability, 11(19), 5343. https://doi.org/10.3390/su11195343
Rasmussen, E. A., & Sørheim, R. (2006). Action-based EE. Technovation, 26(2), 185–194. https://doi.org/10.1016/j.technovation.2005.06.012
Ratten, V. (2013). Cloud computing: A social cognitive perspective of ethics, entrepreneurship, technology marketing, computer self-efficacy and outcome expectancy on behavioural intentions. Australasian Marketing Journal (AMJ), 21(3), 137–146. https://doi.org/10.1016/j.ausmj.2013.02.008
Reid, A., & Gilmore, A., Kolb, A., Stefan, K., Jauhola, E. (2018). Internationalization of Entrepreneurial Marketing Education: Three Nations Project.
Resei, C., Friedl, C., & Żur, A. (2018a). MOOCs and EE-contributions, opportunities and gaps. International Entrepreneurship Review, 4(3), 151–166.
Resei, C., Friedl, C., & Żur, A. (2018b). MOOCs and EE-contributions, opportunities and gaps. 16.
Rippa, P. (2018). Digital academic entrepreneurship_ The potential of digital technologies on academic entrepreneurship. Technological Forecasting, 12.
Robinson, S., Neergaard, H., Tanggaard, L., & Krueger, N. F. (2016). New horizons in EE: From teacher-led to student-centered learning. Education + Training, 58(7/8), 661–683. https://doi.org/10.1108/ET-03-2016-0048
Rodriguez, O. (2013). The concept of openness behind c and x-MOOCs (Massive Open Online Courses). Open Praxis, 5(1), 67–73. https://doi.org/10.5944/openpraxis.5.1.42
Romero, M., & Usart, M. (2013). Serious games integration in an entrepreneurship Massive Online Open Course (MOOC). Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 8101 LNCS, 212–225. https://doi.org/10.1007/978-3-642-40790-1_21
Rueda, L., Benitez, J., & Braojos, J. (2017). From traditional education technologies to student satisfaction in Management education: A theory of the role of social media applications. Information and Management, 54(8), 1059–1071. https://doi.org/10.1016/j.im.2017.06.002
Ruiz-Alba, J. L., Soares, A., Rodríguez-Molina, M. A., & Banoun, A. (2019). Gamification and entrepreneurial intentions. Journal of Small Business and Enterprise Development, 26(5), 661–683. https://doi.org/10.1108/JSBED-09-2018-0266
Secundo, G., Rippa, P., & Meoli, M. (2020). Digital transformation in EE centres-preliminary evidence from the Italian Contamination Labs network. 17.
Seikkula-Leino, J., Ruskovaara, E., Ikavalko, M., Mattila, J., & Rytkola, T. (2010). Promoting EE: The role of the teacher? Education + Training, 52(2), 117–127. https://doi.org/10.1108/00400911011027716

Sexton, D. L., Bowman, N. B. (1984). EE: Suggestions for increasing effectiveness. Journal of Small Business Management, 22(2), 18–25. https://doi.org/10.1016/j.jaci.2012.05.050

Siemens, G., & Tittenberger, P. (2009). Handbook of Emerging Technologies for Learning. Image Rochester NY, 65.

Solórzano-García, M., & Navío-Marco, J. (2019). Developing social entrepreneurs through distance education: The value of commitment and interactivity with the learning community. 21.

Sousa, M. J. (2019). Creating knowledge and entrepreneurial capacity for HE students with digital education methodologies_ Differences in the perceptions of students and entrepreneurs. Journal of Business Research, 14.

Susi, T., Johannesson, M., Backlund, P. (2007). Serious games – An Overview. 2017 IEEE 8th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference, UEMCON 2017, 2018-Janua, 488–491. https://doi.org/10.1109/UEMCON.2017.8249059

Swaramarinda, D. R. (2018). The Usefulness of Information and Communication Technology in Entrepreneurship Subject. 21(3), 10.

Tarabasz, A., Selaković, M., & Abraham, C. (2018). The Classroom of the Future: Disrupting the Concept of Contemporary Business Education. 17.

Tasnim, R. (2013). Playing Entrepreneurship: Can Games Make a Difference? 15.

Toledo, I., Albornoz, C., & Schneider, K. (2020). Learning Analytics to Explore Dropout in Online EE. Psychology, 11(02), 268–284. https://doi.org/10.4236/psych.2020.112017

Vesper, K. H., & Gartner, W. B. (1997). Measuring progress in EE. Journal of Business Venturing, 12(5), 403–421. https://doi.org/10.1016/S0883-9026(97)00009-8

von Graevenitz, G., Harhoff, D., & Weber, R. (2010). The effects of EE. Journal of Economic Behavior & Organization, 76(1), 90–112. https://doi.org/10.1016/j.jebo.2010.02.015

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

Wadhwa, V., & Aggarwal, R. (2009). Anatomy of an entrepreneur: Family background and motivation.pdf. 24.

Waghid, Z. (2017). Using Film and Online Group Blogs to Cultivate a Community of Inquiry: A Case Studied at a University of Technology in South Africa. Progressio, 38(2), 106–131. https://doi.org/10.25159/0256-8853/2103

Waghid, Z., & Oliver. (2017). Cultivating social entrepreneurial capacities in students through film: Implications for social EE. Educational Research for Social Change, 6(2), 76–100. https://doi.org/10.17159/2221-4070/2017/v6i2a6

Watson, J. (2008). Blended Learning: The Convergence of Online and Face-to-Face Education. North American Council for Online Learning, 572, 16. https://doi.org/10.1016/j.aca.2006.05.012

Welsh, D., & Dragusin, M. (2013). The new generation of massive open online course (MOOCS) and EE. In Small Business Institute Journal (Vol. 9, Issue 1, p. 51).

Williams, D. (2015). The Impact of SimVenture on the Development of Entrepreneurial Skills in Management Students. Industry and Higher Education, 29(5), 379–395. https://doi.org/10.5367/ihe.2015.0270

Wraae, B., Tigerstedt, C., & Walmsley, A. (2020). Using Reflective Videos to Enhance Entrepreneurial Learning. EE and Pedagogy, 251512742093695. https://doi.org/10.1177/2515127420936955

Wu, Y. J., Yuan, C. H., & Pan, C. I. (2018). EE: An experimental study with information and communication technology. In Sustainability (Switzerland) (Vol. 10, Issue 3). https://doi.org/10.3390/su10030691

Wu, Y., & Song, D. (2019). Gratifications for social media use in entrepreneurship courses: Learners' perspective. Frontiers in Psychology, 10(MAY), 1–12. https://doi.org/10.3389/fpsyg.2019.01270

Zhou, M., & Xu, H. (2012). A Review of EE for College Students. 17.

4 AI and EE: a scoping review

4.1 Introduction

The terminology of AI, a buzzword, nowadays exceeds the computer science field, combining all trades and professions such as medicine (Holzinger et al., 2019), healthcare (Rong et al., 2020), management (Raisch & Krakowski, 2021), education (Zawacki-Richter et al., 2019) and so on. The definition of AI by Pedro et al. (2019) refers to the human performance and rationality of computers, systems, or software. Specifically, AI technologies identify rules and patterns under big data and data from the Internet of Things with the help of machine learning (Kaplan & Haenlein, 2019). Concerning education, AI, which could be divided into sub-categories such as step-by-step intelligent tutoring system (ITS), automated human-computer interaction, natural language processing, data-mining, and learning analytics, finds itself in all types of disciplines at various levels of education (Cope et al., 2021). Entrepreneurs, via undertaking EE and starting their own businesses, have the potential to decrease the ratio of unemployment and increase the amount of economic growth using innovative products/services and the foundation of ventures, generated as a result of entrepreneurship. AI as a trend of educational technologies, which mainly applies to the realm of higher education, releases the burden of educators via automation and therefore saves time and human resources. However, as illustrated in the scarcity of articles incorporated in this review, the possibility of AI being applied in EE has not been sufficiently discovered in comparison to AI employed in other educational subjects. Thus, as a result of this study, there was a very limited number of reviews relevant to AI techniques being employed in EE in order to take advantage of these technologies for decreasing the human workload (i.e., via automatic assessment), enhancing students' learning experiences and decreasing the costs of identification of entrepreneurial opportunities. In this context, this study aims to provide a review of the status and explore the possibilities of applying AI technologies in EE. Several other technologies have been introduced and applied to EE, especially online EE. ICT and communicative tools enable entrepreneurial learners to discuss and collaborate whilst being in different locations synchronously as well as asynchronously (Chen et al., 2021). Thus, the perceived usefulness of ICT positively impacts the tolerance of

entrepreneurial risks when learners start a business (Bandera et al., 2018). Learning management systems store digital data and through the tracking of learning data, have various means to improve student's learning experiences and/or outcomes in an online learning environment, e.g., by providing relevant and timely feedback, warning educators of students who are at risk of attrition and to make intervention (Ivanytska et al., 2021). Cloud services can provide an opportunity for participants' mobility through the function of synchronization, backup, and cooperation (Holinska et al., 2019). Educational institutes need not hire software engineers to develop their own cloud platforms but to rent services from cloud vendors and provide individual applications (Rajabion et al., 2019). Mobile EE courses bring ubiquitous collaboration and learning (Teymurova et al., 2020). Using ICT, cloud services, mobile devices, and collaboration tools allow learners' relations to potentially become closer and as a result, study more effectively together than if they were not surrounded by educational technologies. These technologies have the possibility of additionally providing learners with opportunities for self-regulated learning as well as the incorporation of learner-centered pedagogical philosophy.

In this paper, a scoping review was utilized to examine the research status of AI applied in EE from the aspects of entrepreneurship teaching and learning. The main reason for adopting a scoping review is that a limited number of papers were identified for the investigation topic. Additionally, a scoping review, a precursor of systematic reviews, summarizes outcomes from heterogeneous or complex realms that have not widely been reviewed, in order to identify gaps in a broad topic (Pham et al., 2014; Tricco et al., 2018), focusing on relevant literature and key concepts of a certain field (Munn et al., 2018). The current research topic is a new and developing area discussed by a small number of academic associations and scholars. Compared to systematic reviews, scoping reviews can explore the latent gaps of AI applied in EE, the basis of the emerging and established fields aiming at broadening research questions (Arksey & O'Malley, 2005; Colquhoun et al., 2014). Medical researchers initially applied for scope reviews as their research methodologies and standardized procedure. Other scholars then transferred and applied to their research domains. Thereafter, pedagogical researchers introduced and applied this review method in the education sector (Turner & Stough, 2020).

The remainder of this study is shown. The reviewed literature related to AI in education (AIED) is presented in section 2, in order to ascertain the state-of-the-art studies on AIED, where we completed a summary of 10 such reviews and extract the possible research orientations in EE thereof. In section 3, we present our scoping review methodology on AI in EE and synthesized published English articles. The results are shown in several tables, presented in section 4, followed by the discussion section that aims to answer three main research questions in this study, in section 5. Finally, section 6 consists of the conclusion, limitations of the research, and future work.

4.2 AIED

Specifically, in this section, we address the research questions (RQ1a and RQ1b):

RQ1a: What AI technologies have been applied to education?

RQ1b: What related theoretical frameworks, especially the pedagogical design of AI in education have been developed?

AIED has been reviewed by scholars and educators in the past several years. To understand the research status quo of AIED and guide for AI in EE (AIEE), we synthesized the main AI technology applied in education and its developed theoretical framework from 10 reviews collected from Google Scholar and ERIC (Education Resources Information Center), shown in Table 4-1. The studies relating to AIED were mainly conducted after the year 2010 (Zhai et al., 2021; Feng & Law, 2021). At the same time, we can find reviews from 2000 (Chen et al., 2022; Talan, 2021) and 1970 (Bozkurt et al., 2021). The duration of each conducted review is often spanning one decade (Hinojo-Lucena et al., 2019) or around two decades and the longest time scope is half of a century (Bozkurt et al., 2021). Zhai and his colleagues (2021), Chen and her colleagues (2022), Bozkurt and his colleagues (2021), Chassignol and her colleagues (2018), and Feng and Law (2021) systematically reviewed specific AI technologies in education. Baker and Smith's report (2019) focused on pedagogical design, little mentioning specific technologies. Cox (2021) narratively reviewed eight design fiction, discussing the impact of AI on higher education. Talan (2021) and Pua and colleagues (2021) used a bibliometric review to map AI keywords. The pedagogical design described in 10 pieces of literature related to AIED is shown in Table 4-1 to answer RQ1b, and the educational application of specific AI techniques is discussed below to answer RQ1a.

Table 4-1 The reviews of AI in education

Author	Theoretical framework
Bozkurt and colleagues (2021)	AI, pedagogy, technological issues
Chen and colleagues (2022)	combine AI technologies with education, learning, and teaching
Zhai and colleagues (2021)	AI technology, pedagogical design, domain knowledge, and human factor
Feng and Law (2021)	three-step multi-scale (macro, meso, micro) framework
Chassignol and colleagues (2018)	educational process (content, teaching methods, assessment, communication) combine with specific AI technology
Baker and Smith (2019)	learner-facing, teacher-facing, and system-facing
Cox (2021)	learning, administration and research
Talan (2021)	Without particular framework, focusing on AI in higher education
Pua and colleagues (2021)	students' learning, the relationship between teacher and machine, risk
Salas-Pilco and Yang (2022)	Pedagogy design: learning, teaching, and management/administration; AI application: predictive modeling in education, AI computer-assisted content analysis, assistive technology, intelligent analytics, image analytics AI techniques, software tools, and algorithms used

Because pedagogical design in certain contexts for learning and teaching needs to be rebuilt in the intelligent age due to the new situation of application and combination between AI and the educational field (Popenici & Kerr, 2017), we reviewed the theoretical framework of AIED based on 10 articles (see Table 4-1). AIED used three levels of theoretical framework, a three-step multi-scale (macro, meso, and micro) framework (Feng & Law, 2021) or a three-tier of architecture with a development layer, application layer, and integration layer (Zhai et al., 2021). Bozkurt et al. (2021) clustered three main themes in AIED--AI technologies, pedagogy, and technological issues. The pedagogical design was separated into learning and teaching, and system/research/management (Baker & Smith, 2019; Cox, 2021; Salas-Pilco & Yang, 2022). In detail, Zhai et al. (2021) added domain knowledge and human factors to their analytical framework. In the specific education process, learning content, teaching methods, assessment, and communication were affected by AI technique (Chassignol et al., 2018). Profiling and prediction, assessment and evaluation, adaptive systems, and

ITS are the keywords (Zawacki-Richter et al., 2019). Pua et al. (2021) identified pedagogical keywords are learning, computer-teacher relationship, and educational information. Bozkurt et al. (2021) mentioned adaptive learning, online learning, human-AI interaction, educational data, and higher education. Talan (2021) visualized ITS in HEIs. In general, AI substitutes human education and it is transferring and redefining our education and pedagogy. In order to briefly conclude the theoretical framework of AIEE, we planned to analyze learning, teaching, and management, discussing the pedagogical design in detail. In this study, learning is student performance and development in EE activities and teaching is the performance and assessment of teaching activities (Salas-Pilco & Yang, 2022). HEIs' administration or management, namely dropout/retention or university performance, was added to the procedure of research.

The specific intelligent technologies applied in education are discussed in this section. Briefly, the 10 studies involve specific AI technologies ranging from big data, adaptive personal learning systems, neural networks, natural language processing, and chatbots (see Figure 4-2 left bar). Specifically, big data in education facilitates learning success, predicting through learning analytics that applies statistics, pedagogy, and AI algorithms/models (Alkhalil et al., 2021). The relevant data produced by learners is collected from various platforms and devices. McAfee and Brynjolfsson (2012) summarized “volume” (large volume), “variety” (various sourcing), and “velocity” (high speed) as the characteristics of big data, differentiating from traditional data. The mentioned features make educational decisions based on different datasets and platforms (Deng & Wu, 2021). Educators and big data scientists need to analyze historical or real-time data to manipulate learning analytics, especially in HEIs. The results of analytics can be easily seen and understood through the way of visualization or dashboard (Sedrakyan et al., 2020). As mentioned in machine learning, artificial neural networks are used as a kind of deep learning method (Yakubu et al., 2020). Supervised/unsupervised/semi-supervised (data is labeled/ not labeled/ both) learning and natural language processing have been adopted in the educational assessment (Alenezi & Faisal, 2020), analyzing learning and testing historical data to build a model that explains and predicts learners' behavior (Li, 2018). Natural language processing has been used in exam assessment by comparison between learners’ replies and ideal

answers (Alenezi & Faisal, 2020). At the same time, natural language processing can be applied to teaching, as well as learning processes (Litman, 2016). For example, natural language processing can be applied in language learning, improving speaking and writing (Klosowski, 2018). This technique is a precondition of human-computer interaction, accelerating human-machine communication, e.g., Apple Siri understands and replies to human audio requests. A chatbot can understand audio and writing text, as a result, a chatbot or robot has been inserted into learning management systems and virtual learning teams to help learners and educators learn learning content and administrate regular tasks (Clarizia et al., 2018; Hien et al., 2018; Hwang et al., 2020; Chen et al., 2020; Ahmad et al., 2021). ITS brings personalized learning or adaptive learning, emulating human tutors or teachers (Castro-Schez et al., 2021). The adaptive/ personalized learning system goes further by means of intelligent assessment (Tang et al., 2021), including ITS in this study. The pedagogical theory of domain of interest is the basis that explains learning behaviors in the intelligent system (Clancey & Hoffman, 2021). Learners easily absorb knowledge and get improved, namely adaptive learning since the system provides learning content based on the current achievement of learners. From the teaching aspect, the system implies automatic technologies to reduce the burden on teachers and time spent on repetitive tasks (Pedro et al., 2019; Schiff, 2021; Ahmad et al., 2021), for example, assignments and evaluations are checked through the system. In the realm of learning, collected data aims to analyze and predict learning success and learning engagement, namely learning analytics (Ifenthaler, 2017; Ifenthaler & Yau, 2020). Identifying gaps in learning and customizing learning content, AI technologies accelerate adaptive and personalized learning, based on learner-centered educational philosophy. From management or administration aspects, administrators and policy-makers have utilized learning management systems supported by robots.

Except for AIED, AI has been applied in business and management education (Elhajjar et al., 2021; Xu & Babaian, 2021). The common AI technologies are visual analytics (Zhang & Chan, 2021), learning or data analytics in business administration students (Jena, 2018; Lu, 2022). In this study, the status of AIEE was reviewed and the findings might be useful for business and management education, imploring utilizing

possibilities on basis of AIED. This summary of the 10 relevant reviews is also a contribution to knowledge relating to AI and its application in other educational fields.

4.3 Methodology

According to the framework of scoping review built by Arksey and O'Malley (2005) and further explained by Colquhoun and colleagues (2014), the following main steps: identifying the research question; identifying relevant studies; selecting relevant studies; charting the data, and summarizing, as presented below. We reviewed our research procedure using a checklist with 22 items confirmed by Tricco and her colleagues (2018). This scoping review aims to address and identify the gap in AIEE, accompanying broadly available literature and lacking rigorous evidence. Therefore, this review mainly replies to the "what" question (O'Flaherty & Phillips, 2015; Suryavanshi et al., 2020). Our research questions, as mentioned in section one, RQ1a and RQ1b are answered in section 2, which showed a preliminary review of the AIED. RQ2 and RQ3 are answered in section 4, where we provide a detailed analysis of the scoping review of AI applied to EE, its methodology is presented below.

4.3.1 Identifying relevant studies

Any synonyms surrounding AI and EE in the search terms are collected to broaden the search strings. The scenario of the study only includes HEIs, excluding the industry sector of entrepreneurial and intrapreneurial training. Machine learning and deep learning are the further development of AI (Copeland, 2016). Both of them contain big data, including data mining and data analysis. When typing in "artificial intelligence" during our pilot search, the results in Google Scholar showed keywords: machine learning, deep learning, and other variants of intelligence. Based on the reviewed intelligent technologies in other educational fields, we adopted "machine learning," "big data," and "deep learning" as search strings. Meanwhile, the synonyms of entrepreneurship were taken into consideration. Thus, education went further with "learning", "teaching", and "administration". The results of title screening in our pilot review adopted combined search terms, "intelligen*" and "start a business", being irrelevant to research questions. Additionally, "administration" combined with AI and entrepreneurship is hard to be found. Therefore, we iterated and defined the final search strings: ("artificial intelligen*" OR "machine learning" OR "deep learning" OR

"big data") AND ("entrepreneur*" OR "startup" OR "business plan") AND ("learning" OR "teaching" OR "education").

The following electronic databases were scanned: Web of Science and Google Scholar, supplied by ERIC. Based on entrepreneurship and entrepreneurial learning/teaching journals on Scope, this study collected peer-review papers from *Entrepreneurship Theory and Practice, Entrepreneurship Education and Pedagogy, the Journal of Entrepreneurship Education*, and *Entrepreneurship Education.* The scientific journals refer to AI and education: *International Journal of Artificial Intelligence in Education, Computers in Human Behavior, Computers and Education, British Journal of Educational Technology, International Journal of Emerging Technologies in Learning, Computer Application in Engineering Education, Computer Application in Engineering Education,* and *Educational Technology Society* from a bibliometric study by Talan (2021) with the number of related papers over 60. This scoping review was conducted between October 2021 and February 2022 with an update in April 2022.

4.3.2 Selection of relevant studies

In order to collect highly relevant and good-quality studies of AIEE, the research team discussed and determined inclusion and exclusion criteria in three online meetings (each duration of about 30 minutes) and one presentation in a seminar with 16 Ph.D. students and one professor. We modified and agreed on the criteria, including and excluding literature in the end. Six criteria are shown below:

- As discussed with our team, the titles of the included papers should be relevant to entrepreneurship/entrepreneurs, rather than finance/business/management. Since the latter is broad, the study topic needs to be narrowed;
- AI as a learning or teaching tool was included, whereas AI as learning content or curriculum was not considered. Educators teach how to start a business employing AI technologies, not how to program and optimize AI algorithms in this study;
- The article mentions entrepreneurship without education was omitted. All included research is under an educational scenario, namely learning, teaching, or administration;

- Low reliability and viability of research are excluded to avoid potential bias. For example, the research design of individual studies needs to be improved (Zawacki-Richter et al., 2020);
- The included pieces of literature were published from January 2010 to March 2022 and the full text is available online, written in English. Because MOOCs and other online learning came into public view in the 2010s (Ifenthaler et al., 2012). Thus, AI penetrated our daily life through smartphones and computers with intelligent functions since 2010 (Reynoso, 2021);
- We did not include the articles that mentioned AI in the title and/or abstract but did not explain how to use it in the main content, as scholars mentioned AI as a background.

The procedure of scoping review can be seen in Figure 4-1 in detail drawn in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) following a chart of scoping review. 173 articles were included in the identification and screening step by means of the title screen. Screening title and abstract extracted 20 papers in the eligibility step. We included literature consisting of journals article (*N* = 10) and conference proceedings (*N* = 1) through a full-text review at the end. Nine research were extracted basis on the procedure of scoping review. Two were traced by reference or called snowballing.

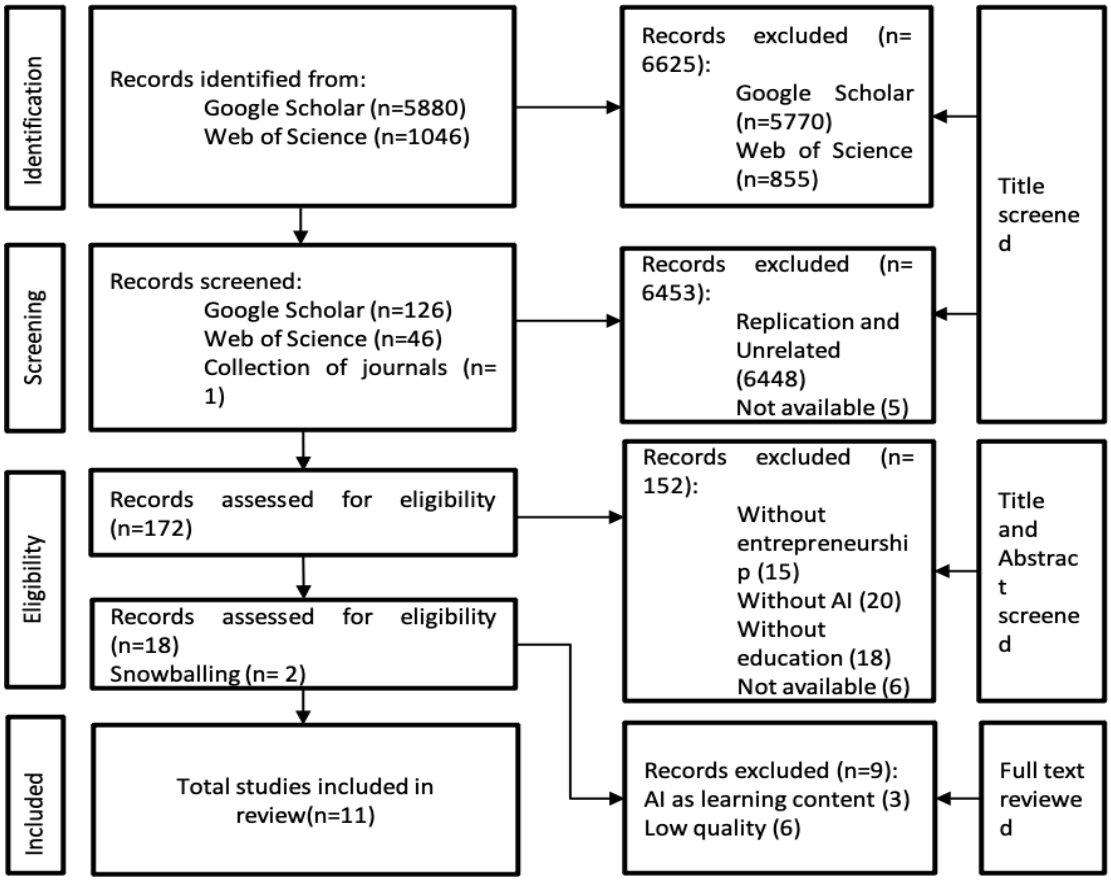

Figure 4-1 PRISMA flow diagram (Cf.Turner & Stough,2020)

4.4 Results

In our study, it was found that a limited number of educators utilized AI technologies to improve students' learning performance while undertaking EE courses. The detailed results of 11 studies were shown in Table 4-2 coded by two authors, adoption of AI technology, the definition of intelligent technology, research question, education purpose, research method, sample, country, and publication. The comparison between AIED (left bar) and AIEE in the specific AI technique (right bar) was drawn in Figure 4-2.

Table 4-2 AI technologies in entrepreneurship education

Authors	Adoption of AI technology	Definition of applied AI technology	Research method	Sample size	Education purpose			Research question	Country	Publication
					T	L	M			
Tkachenko et al. (2019)	Machine learning (fuzzy model and neural network)	Standpoint of cognitive understanding of information development of the entrepreneurial training	Qualitative research	n/a	+			M-machine concept for development of the AI technology in provision of the entrepreneurial education	UK	Journal of Entrepreneurship Education
Liang et al. (2021)	Machine learning (Neural network)	n/a	Experiment study	30 (20 training, 10 test data)	+			Sustainability evaluation of innovation and entrepreneurship education for clean energy majors in HEIs	China	Sustainability
Karra et al. (2021)	Intelligent recommendation (Word2Vec), data mining	Identifying the innovation projects	OWLREADY2 library for manipulating the ontology	A system was validated	+			Recommendation model of entrepreneurial project	Tunisia	Journal of Healthcare Engineering
Botha et al. (2020)	Machine learning (neural networks)	A technique to identify patterns and trends in a string of behaviors	Experiment study	150 samples (125 valid)	+	+		Test non-linear relationships and compare with linear regression model	South Africa	Development Southern Africa
Deng & Wu (2021)	Data mining	Extracting implicit and useful data from many kinds of data	Experiment study	n/a	+			The authors constructed and verified a model based on data mining	China	Arabian Jouranl for Science and Engineering
Sedkaoui (2018)	Big data (Data analytics)	A natural crop of the advanced digital artifacts and their	Qualitive research	n/a		+		The potential of introducing big data analytics as a learning process in higher	France	International Journal of Innovation Science

		applications (volume, variety, velocity)				education intended to develop entrepreneurship		
Xu & Zhang (2021)	Machine learning (Wavelet neural network)	A mathematical model, similar to the human nervous system	Experiment study	20 graduates	+	Analysis and prediction model of college students' entrepreneurial psychology	China	Frontiers in psychology
Ahmed & Ganapathy (2021)	Intelligent content with LMS	AI for content customization	Qualitative research	n/a	+	AI for learning management	China	Academy of Entrepreneurship Journal
Wang et al. (2020)	Machine learning (support vector machine algorithm)	Pattern recognition and neural networks	Experiment study	n/a	+	ABC algorithm, the search mode of the bee and follower bees is single, balancing the global and local search capabilities	China	Computational Intelligence
Chen (2021)	Machine learning (Fuzzy neural network)	improve the real-time scheduling and collocation ability of the innovation and entrepreneurship education model of college students FNN control the innovation and entrepreneurship education model of college students	Experiment study(survey)	219	+	Improve the automatic scheduling and control method, innovation and entrepreneurship education model for college students based on fuzzy neural network	China	Security and Communication Networks

Toledo et al. (2020)	Bid data (learning analytics)	n/a	Survey and log data on learning system	23 participants with both survey and platform data	+	using learning analytics to explore the case of dropout during a female-oriented online entrepreneurship educational program	Chile	Psychology

Note: L= learning, T= teaching, M= management, n/a = not available

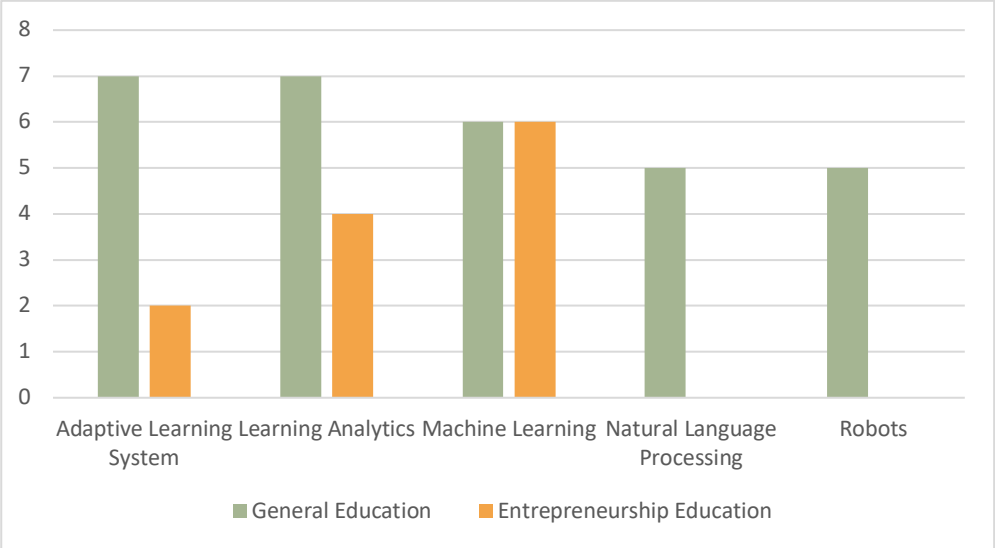

Figure 4-2 Comparison of specific AI techniques in education and EE

4.4.1 AI technologies in EE

We address our second research question in this section:

RQ2: What specific AI technologies have been utilized in EE?

AI technologies that have been applied in EE are (1) big data analytics, (2) machine learning, and (3) adaptive/personal learning system, as described below.

Big data analytics

Four studies discussed data mining and data analytics (Deng & Wu, 2021; Toledo et al., 2020; Sedkaoui, 2018; Karaa et al., 2021). Findings showed that (1) even though big data analytics were widely applied in education, scholars in EE less used this intelligent technique to teach, learn, and manage. Specifically, universities and colleges reveal students' learning needs and preferences under big data and provide personalized learning guidance with the assistance of algorithm models in education. In EE, scholars constructed a model based on big data mining and analytics to define the procedures and elements of EE (Deng & Wu, 2021). Learning analytics method found eight potential factors affecting entrepreneurial women's high dropout rate in the online EE environment by means of both survey and log data (Toledo et al., 2020). To identify the gap between market demands and existing learning projects, big data technology guided by pedagogical design has tailored learning modules for entrepreneurial learners (Sedkaoui, 2018); (2) big data analytics in EE operates entrepreneurship analytics to predict the success of an entrepreneurial project for learners. Both business analytics and entrepreneurship analytics extract data from multiple datasets to make

decisions. Different from business analytics, the focus of entrepreneurship analytics is entrepreneurial activities, namely not how to run a company, but how to start or create a business successfully and predict business models through big data (Sedkaoui, 2018; Karaa et al., 2021). Thus, entrepreneurial analytics applies data insights to social, environmental, and economical sustainable development, extracting entrepreneurial opportunities/ideas and enhancing learners' entrepreneurial competencies (Sedkaoui, 2018); (3) data storage, multiple modal data, and the amount of data were considered by EE scholars and educators. In accordance with data privacy laws, entrepreneurial data was stored in learning management platforms or systems, the Academic Affairs Office, and Career Guidance Center, as well as social media, to construct a model for EE skills training (Deng & Wu, 2021). For example, data sources from Twitter were extracted for a recommendation of startup projects (Karaa et al., 2021; Toledo et al., 2020). Social media data varies from text and number to emoji. To deal with multiple data sources and large volumes of data intelligently, Karaa et al. (2021) employed Word2Vec for data processing and achieved 1,529,775 tweets. The following two studies, however, extracted a small amount of data. Deng & Wu (2021) introduced a global multi-granularity decision-theoretic rule induction model, accompanied by the Delphi method and tested by 92 college students from EE courses. A survey with 23 participants and platform log data were captured (Toledo et al., 2020). Findings showed that except for getting data from social media software, educators and scholars should use big data produced in school environments and learning systems, to improve instructional design and learning performance in the context of EE. In the fourth study of literature on big data, no data were collected but rather a qualitative explanation was given for the reason for the application of big data in EE (Sedkaoui, 2018).

To summarize, findings showed that (1) although big data analytics in EE was broad or general compared to other educational fields, EE research has used this intelligent technique in teaching, learning, and management; (2) big data analytics in EE operates entrepreneurship analytics to predict the success of an entrepreneurial project for learners; (3) entrepreneurial data was stored in various datasets. Research can capture learners' multiple-modal data and extend the amount of data if possible.

Machine learning

Six of 11 studies mentioned machine learning (Wang et al., 2020; Xu & Zhang, 2021; Liang et al., 2021; Tkachenko et al., 2019; Botha et al., 2020; Chen, 2021). The findings were coded from data sourcing, sample size, pedagogical design, research purpose, machine learning algorithm, and validation of algorithm, summarized from Luan and Tsai's (2021) machine learning analysis methodology.

Four studies pointed out the collected number of samples and data sourcing. Three of the research employed split validation (train and test data). Xu and Zhang (2021) adopted 20 samples (*N* = 10 trained and *N* = 10 tested) from a survey. Liang and colleagues (2021) used 30 samples (20 universities to train and tested 10 institutes) by field research. Botha and colleagues (2021) trained 89 and tested 36 entrepreneurship graduates. Chen (2021) used physical information by means of information-sensing recognition to build nodes and surveyed 219 participants to test nodes and models. Tkachenko and colleagues (2019) and Wang and colleagues (2020) did not mention the sample size or data source in their studies.

For pedagogical design and research purposes, we found two studies that introduced neural networks (machine learning algorithms) to implore the relationship between independent variants and dependent variants. In detail, Wang et al. (2020) identified relationships from both the general and detail of EE. Botha and her colleagues (2021) discussed the relationship between prior entrepreneurial exposure, EE, and entrepreneurial action. The procedure or stages of neural networks are applied to the design of entrepreneurial tasks and activities (Tkachenko et al., 2019). In addition, the evaluation of EE was discussed in three studies. Xu and Zhang (2021) diagnosed students' entrepreneurial psychology. Liang and his colleagues (2021) constructed and recommended the index system of sustainability of EE for clean majors using intelligent evaluation algorithms. It may also be possible to build a model to diagnose and predict the effectiveness of EE (Chen, 2021) and entrepreneurial student management (Wang et al., 2020).

In contrast with other algorithms, neural networks, like the human neural network, are not traditional AI techniques due to their nonlinear processing, self-organization, and reasoning capabilities (Xu & Zhang, 2021). Neural networks are normally combined with other algorithms, such as pattern recognition (Botha et al., 2021), fuzzy models (Chen, 2021; Tkachenko et al., 2019), wavelet transform (Xu & Zhang, 2021), and so on. In an

applicated example, Liang and his colleagues (2021) optimized an evaluation module partly by generalized regression neural network. Wang and his colleagues (2020), however, adopted a support vector machine algorithm to improve the management of employment and entrepreneurship. So neural networks and support vector machines are two main algorithms in EE. Overall, the findings were coded from the data sourcing, sample size, pedagogical design, research purpose, machine learning algorithm, and validation of algorithms.

Adaptive/personalized learning system

The results indicated that in the 11 literature, the minority (*N* = 2) (Karaa et al., 2021; Ahmed & Ganapathy, 2021) adopted an adaptive/personalized learning system. Specifically, one is an intelligent recommendation for a startup project (Karaa et al., 2021), and the other discussed automated content on a learning system embedded with AI (Ahmed & Ganapathy, 2021). Additionally, we found many systems and platforms that provide EE courses. However, most of them are traditional learning systems, lacking intelligence and adaptation. In other words, all learners learn the same content at the same pace. Despite this, there are still several systems that provide automated personalized responses to learning management services.

Currently, the use of intelligent recommendation systems recommends entrepreneurial projects in entrepreneurship learning and teaching. Through intelligent recommendation systems and big data, learners are able to design their own startup projects and educators can predict how those projects will be. One of these systems is based on the data of social networks for a recommendation of startup projects (Karaa et al., 2021). The recommendation model aims to recommend entrepreneurial projects, beneficial for smart cities and smart health projects (Karaa et al., 2021). An intelligent management system speeded up data classification, generating metadata stored in Cloud (Ahmed & Ganapathy, 2021). The recommendation for startup projects was based on the Word2Vec algorithm (Karaa et al., 2021). Stored data on the system is not all of them are useful (Ahmed & Ganapathy, 2021), so we capture useful information from noise on the system or other tracking data in datasets.

4.5 Discussion

This section discusses the status of AIEE in terms of data analytics, intelligent learning systems, and machine learning to answer RQ3, and we predict the latent leverage of other AI technologies (natural language processing and chatbots) in EE.

RQ3: What other AI technologies can be applied to EE on basis AIED?

4.5.1 AI technologies in EE

Data analytics

Big data technology penetrates into teaching, learning, and management and analyzes participants' and environmental information, getting formative and summative evaluation data. Similar to other educational fields, EE participants use data analytics as an educational tool to predict their learning outcomes and improve learning environments (Yılmaz & Çakır, 2021). Specifically, from learning aspects, learning analytics capture and analyze data produced by learners to predict and report learning results. Mining a large volume of EE data is a precondition for software engineers and educators to construct models or patterns to facilitate learning performance. Learning analytics in education has been validated in four areas: learning effectiveness, facilitator for learning and teaching, deployment, and ethics (Viberg et al., 2018; Schumacher & Ifenthaler, 2018). Scholars in EE are considering these topics currently or soon. The collection of educational data is a challenge so entrepreneurial learning analytics extract learning data from multiple platforms and entities in F2F and online learning environments as much as possible. Additionally, the feature of EE, learning from experience, requires practical activities for improving learners' entrepreneurial competence. Thereof, entrepreneurial learning analytics and its application are more complicated than AIED. EE learning results could be the formation of a startup company offering a new product or service, which is difficult to quantify by standardized measures. From the standpoint of teaching, entrepreneurial educators store and process data to optimize entrepreneurial activities. Data-driven entrepreneurial teaching decision-making is robust, being supported by educators' intelligence. Data analytics, a new opportunity, formatively assesses learning results and gives hints to learners, maintaining a high retention rate of EE courses. The presentation of EE data analytics needs to learn from other educational fields, especially in the visualization of the assessment (Ifenthaler, 2014), to increase the readability of results. Overall, data analytics in EE needs to stand on the shoulders of other disciplines (especially

deployment and ethics) and reach new heights with many visible and invisible possibilities and solutions to problems.

From an entrepreneurial stance, entrepreneurial analysis, a section of business analytics, focuses on entrepreneurial opportunities and the traits of learners. That says, entrepreneurship analytics cleans and analyzes data using algorithms to predict the success of start-up projects (Arshi et al., 2021), e.g., Tweet data predict entrepreneurs' business models (Ebert et al., 2018). Big data itself impacts the business model innovation (Ciampi et al., 2021). 12 attributes of entrepreneurship are embedded with big data, ensuring sustainable development of the EE (Ma et al., 2020). To identify potential entrepreneurs, entrepreneurial analysis adopts psychometric scales, e.g., Big Five Personality traits test whether learners have strong entrepreneurial intentions mediated by other factors (Ahmed et al., 2022; Awwad & Al-Aseer, 2021). Hence, entrepreneurial analytics retrieves data relevant to business/market trends and nascent entrepreneurs (Neumeyer, 2021). The other disciplines of the education sector can learn from EE how to extract learners' data from complicated environments both in and out of school, considering the theoretical basis of the pedagogical psychology of a particular discipline.

Ferguson pointed out that learning analytics needs "a shift away from a technological focus towards an educational focus" (Ferguson, 2012, *p.*305). EE educators, policy-makers, and other stakeholders should focus on pedagogical design, namely how to combine technology with EE appropriately. Data analytics in EE can go further basis on other disciplines to optimize diagnosis, prediction, intervention, and recommendation of the EE (Luan & Tsai, 2021). Educational big data include micro-level data from different kinds of learning management systems and MOOCs platforms, meso-level data with assignments and online discussions, and macro-level infrequently updated data generated by learners' behavior (Fischer et al., 2020). The current EE analyzed data is coarse-grained. Educators need to capture and retrieve multimodel data relevant to learners' performance, from mouse clicks to times of attempts, and facial recognition (Sharma et al., 2019; Wang, 2016), as well as cognitive, motivational, and emotional data (Noroozi et al., 2020). Retrieved data produced by learners aim to teach in a targeted manner (Ma et al., 2020). Additionally, similar to other disciplines, the data quality and extraction methods need to be considered (Ifenthaler & Yau, 2020) in EE.

To summarize this section, big data technology penetrates teaching, learning, and management to mine and analyze participants' and environmental information, getting formative and summative evaluation data. From an entrepreneurial stance, entrepreneurial analysis, a section of business analytics, focuses on entrepreneurial opportunities (market and program data) and the traits of learners.

Machine learning

In EE courses, machine learning is applied to verify learners' entrepreneurial ideas, analyzing the initial data (Mavlutova et al., 2020). In order to increase validity and avoid performance bias, machine learning usually should validate models based on samples with high dimensions or big data (Balki et al., 2019; Vabalas et al., 2019). A small sample size might threaten the effectiveness of the algorithm (Winkler-Schwartz et al., 2019), although the research adopts a split validation (An et al., 2021). The included literature in this study had a relatively small sample size, except for one study with Tweet data. By testing and training the model, scholars exchange the training and testing data, as well as explore more data from various datasets, from social media to learning management platforms and surveys/interviews to achieve higher performance of models.

The findings showed that machine learning in EE seldom focuses on specific pedagogical design. Whereas in other disciplines, machine learning is applied to individualized learning, prediction of learning failure, and assessment of learning results (Hodges & Mohan, 2019; Luan & Tsai, 2021; Zhou et al., 2018). Machine learning needs to combine entrepreneurial pedagogy and learning goals, facilitating learners' entrepreneurial knowledge, skills, and mindset. According to the topics/purposes of EE research, neural networks identify impact factors of EE and explore the effectiveness of diverse approaches to the EE (Blenker et al., 2014; Salas-Rueda, 2021). Assessment and evaluation of entrepreneurial assignments are suitable to apply machine learning. However, the non-standardized answer is personalized, long, and hard to analyze by computers. Except for building corpora, based on entrepreneurship as a process of design (Berglund et al., 2020), educators and software developers can standardize the procedure of EE. For example, we can adopt design thinking steps: the empathize, define, ideate, prototype, and test-of-design thinking inspired by Herbert Simon, describing the detailed requirements and tools of each step in learning management

systems. Developers train and optimize algorithm models, releasing the educators' burden of assessment and achieving EE assessment with high accuracy (Saha & Rao, 2022).

Machine learning algorithms were applied in social science, e.g., the bag-of-words algorithm and deep learning with a long-short-term memory layer had the best performance in the classification of entrepreneurs from the British census data (Montebruno et al., 2020). Except for neural networks and support vector machines reviewed in this study, other popular algorithms: regression, decision tree, and Bayes employed in the science education (Zhai et al., 2020) can be introduced into entrepreneurial learning assessment directly, optimizing algorithms and models based on questions to solve. Analyzing big data, machine learning used in learning recommendation systems provides personalized learning content and guidance (Khanal et al., 2020). To summarize this section, we explore more data from various datasets, from social media to learning management platforms and surveys to achieve higher performance of models. Machine learning needs to combine entrepreneurial pedagogy and learning goals, facilitating entrepreneurial knowledge, skills, and mindset.

Adaptive/Personalized learning system

The step-by-step ITS, AIED in the beginning period, is a predecessor to an adaptive/personal learning system, integrating the user interface model, pedagogical model/teaching strategies model, domain knowledge model, and student model. The interface model connects users and the system. The pedagogical model also called the expert model, selects a suitable response that fits the interaction between learners and domain knowledge. Domain knowledge refers to the knowledge of a particular discipline. The student model generates learning data that can be used in other models (Almasri et al., 2019). To facilitate the adaptiveness function, ITS added other modules, i.e., the personal learning module, to the four basic modules (Erümit & Çetin, 2020). EE systems are currently less intelligent and personalized than other disciplines. Specifically, the current system or platform cannot offer useful and suitable hints, guidance, and personalized content for starting a business lacking individualized learning paths and remedial instruction, leading to personalized guides needing human tutors' assistance.

The ideal EE adaptive/personalized learning system makes ITS smart basis on a knowledge model with knowledge graphs, a student model with multimodal data, a dynamic pedagogical model, and adaptive interaction. In detail, the developer builds an automatic and personalized learning system for learners on the basis of their behavior and needs, assessing learning results and providing individualized content, learning requirements, and learning pathways (Muangprathub et al., 2020). The adaptive/personalized learning system includes intelligent elements, for example, Scooter, an intelligent tutor added to a learning system, responds with positive or negative emoji in accordance with learners' behavior (Baker et al., 2006). Individual learners' learning performance is enhanced by optimizing AI algorithms and well-organized instruction design in the adaptive learning systems (Brusilovsky et al., 2004; Liu et al., 2017). The incorporation of adaptive learning systems has been found to yield a moderate-large impact on the field of social sciences (Kulik & Fletcher, 2016) with even a higher effect size than mathematics and other disciplines (Ma et al., 2014). EE participants can merge the personalized learning system with the current one guided by constructivists with an updated pedagogical design.

Except for learning and teaching recommendations, entrepreneurship recommendation systems recommend startup projects or predict business success (Wu et al., 2021; Żbikowski & Antosiuk, 2021). Recommendation systems provide startup projects for investors and enterprises on the basis of the personalized investment preferences of people and organizations (Xu et al., 2020) and technological similarities between enterprises and startup projects (Kim et al., 2020). In a word, past behaviors data and users' preference data improve the accuracy of the recommendation system (Javed et al., 2021). Therefore, recommendation systems manage entrepreneurship, entrepreneurs, and innovation to intelligently make decisions, and construct entrepreneurship and innovation models in the platforms (Yang et al., 2014).

To summarize, EE systems, currently, are less intelligent and personalized than other educational fields. EE participants can merge the personalized learning system with the current one guided by constructivists in the four basic models. The entrepreneurship recommendation systems manage entrepreneurship, entrepreneurs, and innovation to intelligently make decisions to construct entrepreneurship and innovation models.

4.5.2 Other AI technologies apply to EE

In Figure 4-2, we visualized specific AI technologies in the other educational fields and EE. Natural language processing and chatbots have been applied to the former. This study, however, did not find their application in EE. The following discussed the possibility of their utilization in EE. We discuss natural language processing and Chatbots thereafter, as these are possibly introduced to EE in the near future.

Natural language processing

This section provides a brief explanation of natural language processing and its possibility in EE. Given the limitation of the amount of published English literature, the existing applications of AIED might inspire EE educators and stakeholders to consider other AI technologies. Natural language processing has been employed in the field of other educational fields, to analyze learning content, writing, and reading (Burstein, 2009; Davidovitch & Eckhaus, 2020), especially in data processing of language learning. Thus, the textual analysis provides a basis for solutions to problems, e.g., assessment of learning performance (Solano et al., 2021; Marutschke et al., 2021; Pandey et al., 2017).

Entrepreneurial educators can transcript rich EE data into text utilizing natural language processing, producing data sets with critical knowledge and competencies. Constructing a model and optimizing algorithms aims to analyze text, measure achievement, and improve the performance of EE activities by analyzing open-ended assignments. For example, a business plan assessment is automatically conducted based on predefined quality metrics employing Word2vec and other algorithms, comparing the results with human assessment and finding out the best algorithm (Smith et al., 2020). So, the starting point might be to evaluate sections of business plans, training, and testing short-text answers in databases.

Chatbots

In this section, we provide a brief explanation of the merits of chatbots in other educational disciplines and their possibility in EE. The brief procedure of utilization of chatbot: the end-user inputs text or speech data and chatbots reply to users by getting stored data of relevance in their databases (Adamopoulou & Moussiades, 2020; Clarizia et al., 2018). The merits of the application of chatbots are significant. For example, a question-and-answer chatbot answers learners' confusion without time limitations

(Palasundram et al., 2019). Whereas the demerit is queried information not possible to be customized in the chatbot (Sreelakshmi et al., 2019). Based on a systematic review by Pérez et al. (2020), the purpose of a chatbot offers service or optimizes learning administration. Additionally, a chatbot improves learning and teaching performance, supporting instructional processes in various disciplines.

EE is no exception. Retrieving customized content, AI chatbots and predictive analysis were combined with learning management systems (Ahmed & Ganapathy, 2021). Chatbots inside EE learning platform answer high-frequency service questions to improve learners' satisfaction through requesting datasets. Educators introduce chatbots to interpret entrepreneurial knowledge. When students submit un-structured assignments, the supervisor bot confirms with learners that their submission and meets the standardized and personalized requirements within the human-computer dialogues (Gonda et al., 2018). Entrepreneurial learning systems or platforms embed chatbots, increasing flexibility and interaction between learners and content. Although chatbots solve low-order problems through communication and interaction to a certain degree, human communication in EE activities inspires new ideas using high-order thinking and innovation. The communication involved with a chatbot is still in the initial. Thus, a human-like discussion we want requires a long period and sophisticated machine learning algorithms to optimize.

4.6 Conclusion, limitations, and future research

4.6.1 Conclusion

Now AI penetrates education. The application of AIED has a long time and many attempts. Technology impacts the process of venture creation (Elia et al., 2020). Scholars following the trend, educational technologies have been introduced into online and F2F EE courses. However, AIEE is a new field with many opportunities and learning from other educational fields. And the characteristics of EE are partly different from other disciplines, which need special learning designs and instruction designs. Based on our review, AIEE introduced big data, adaptive/personalized learning systems, and algorithms of machine learning. Big data analytics use multimodal data to improve the effectiveness of EE and spot entrepreneurial opportunities. Adaptive/personalized learning systems provide personalized suggestions and guides. Rapid feedback and individualized learning are the advantages of these systems. Entrepreneurial analytics

analyzes entrepreneurial projects with low costs and high effectiveness. Machine learning releases educators' burdens and improves the accuracy of the assessment. However, AIEE needs more sophisticated pedagogical designs in diagnosis, prediction, intervention, prevention, and recommendation, combined with specific entrepreneurial learning content and entrepreneurial procedure, obeying entrepreneurial pedagogy and educational technology pedagogy.

In light of our findings, natural language processing and chatbots have not been found in EE literature but apply to other educational areas. To improve the effectiveness of EE, natural language processing optimizes algorithms to analyze text and measure achievement. A chatbot can answer repeated questions and facilitate participants' collaboration and cooperation in online learning platforms or systems. Scholars build a robust scientific basis for the research of AIEE, especially in the online learning context. In light of intelligent algorithms, AIEE provides more collaborative possibilities, peers, learners and educators, and human-machine interaction.

4.6.2 Limitations and future research

The limitations of the research and methodology are clear but difficult to avoid because of objectiveness: the current number of published literature relevant to AIEE is rare, leading to the adoption of scoping review that is difficult to make a systematic review or meta-review and operate a highly robust study. The results learned from limited literature and the results might be difficult to apply to other fields and inspire our counterparts. Meanwhile, the pedagogical design of AIEE seldom offers useful hints for other disciplines, because the majority of explanation and application of AI used in EE is generic and unclear, not detailed.

We hope the research topic about AIEE goes further. From pedagogical design aspects, further research might be an experimental study in which entrepreneurial educators apply AI technologies to particular entrepreneurial content and context using optimized pedagogical design in-depth. We can learn from the experience of other disciplines in a combination of AI and pedagogy design. From the AI technologies aspect, we might combine two or more AI technologies in EE courses, absorbing their advantages. For example, we can attempt deep learning and other verified algorithms to learn, teach, and manage entrepreneurial knowledge, skills, and mindsets, capturing learners' multimodal data and optimizing AI models.

References

Adamopoulou, E., & Moussiades, L. (2020). An overview of chatbot technology. IFIP International Conference on Artificial Intelligence Applications and Innovations, 373–383.

Ahmad, S. F., Rahmat, M., Mubarik, M. S., Alam, M. M., & Hyder, S. I. (2021). Artificial Intelligence and Its Role in Education. Sustainability, 13(22), 12902.

Ahmed, C. of A. C. with E. A. I. A. S. on L. M. S. for E. E., & Ganapathy, A. (2021). Creation of Automated Content with Embedded Artificial Intelligence: A Study on Learning Management System for Educational Entrepreneurship. Academy of Entrepreneurship Journal, 27(3), 1–10.

Ahmed, M. A., Khattak, M. S., & Anwar, M. (2022). Personality traits and entrepreneurial intention: The mediating role of risk aversion. Journal of Public Affairs, 22(1), e2275.

Alenezi, H. S., & Faisal, M. H. (2020). Utilizing Crowdsourcing and Machine Learning in Education: Literature Review. Education and Information Technologies, 25(4), 2971–2986. https://doi.org/10.1007/s10639-020-10102-w

Alkhalil, A., Abdallah, M. A. E., Alogali, A., & Aljaloud, A. (2021). Applying big data analytics in higher education: A systematic mapping study. International Journal of Information and Communication Technology Education (IJICTE), 17(3), 29–51.

Almasri, A., Ahmed, A., Almasri, N., Abu Sultan, Y. S., Mahmoud, A. Y., Zaqout, I. S., Akkila, A. N., & Abu-Naser, S. S. (2019). Intelligent tutoring systems survey for the period 2000-2018.

An, C., Park, Y. W., Ahn, S. S., Han, K., Kim, H., & Lee, S.-K. (2021). Radiomics machine learning study with a small sample size: Single random training-test set split may lead to unreliable results. PloS One, 16(8), e0256152.

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. International Journal of Social Research Methodology, 8(1), 19–32. https://doi.org/10.1080/1364557032000119616

Arshi, T. A., Islam, S., & Gunupudi, N. (2021). Predicting the effect of entrepreneurial stressors and resultant strain on entrepreneurial behaviour: An SEM-based machine-learning approach. INTERNATIONAL JOURNAL OF ENTREPRENEURIAL BEHAVIOR & RESEARCH, 27(7), 1819–1848. https://doi.org/10.1108/IJEBR-08-2020-0529

Awwad, M. S., & Al-Aseer, R. M. N. (2021). Big five personality traits impact on entrepreneurial intention: The mediating role of entrepreneurial alertness. Asia Pacific Journal of Innovation and Entrepreneurship.

Baker, R. S. J. d., Corbett, A. T., Koedinger, K. R., Evenson, S., Roll, I., Wagner, A. Z., Naim, M., Raspat, J., Baker, D. J., & Beck, J. E. (2006). Adapting to When Students Game an Intelligent Tutoring System. In M. Ikeda, K. D. Ashley, & T.-W. Chan (Eds.), Intelligent Tutoring Systems (Vol. 4053, pp. 392–401). Springer Berlin Heidelberg. https://doi.org/10.1007/11774303_39

Baker, T., & Smith, L. (2019). Educ-AI-tion Rebooted? Exploring the future of artificial intelligence in schools and colleges (p. 56).

Balki, I., Amirabadi, A., Levman, J., Martel, A. L., Emersic, Z., Meden, B., Garcia-Pedrero, A., Ramirez, S. C., Kong, D., & Moody, A. R. (2019). Sample-size determination methodologies for machine learning in medical imaging research: A systematic review. Canadian Association of Radiologists Journal, 70(4), 344–353.

Bandera, C., Collins, R., & Passerini, K. (2018). Risky business: Experiential learning, information and communications technology, and risk-taking attitudes in entrepreneurship education. The International Journal of Management Education, 16(2), 224–238.

Berglund, H., Bousfiha, M., & Mansoori, Y. (2020). Opportunities as artifacts and entrepreneurship as design. Academy of Management Review, 45(4), 825–846.

Blenker, P., Elmholdt, S. T., Frederiksen, S. H., Korsgaard, S., & Wagner, K. (2014). Methods in entrepreneurship education research: A review and integrative framework. Education+ Training.

Botha, M., Pohl, M., & Mubita, L. (2021). Modelling the relationship between prior entrepreneurial exposure, entrepreneurship education and entrepreneurial action using neural networks. Development Southern Africa, 38(2), 264–281.
Bozkurt, A., Karadeniz, A., Baneres, D., Guerrero-Roldán, A. E., & Rodríguez, M. E. (2021). Artificial intelligence and reflections from educational landscape: A review of AI studies in half a century. Sustainability, 13(2), 800.
Brusilovsky, P., Karagiannidis, C., & Sampson, D. (2004). Layered evaluation of adaptive learning systems. International Journal of Continuing Engineering Education and Life Long Learning, 14(4–5), 402–421.
Burstein, J. (2009). Opportunities for natural language processing research in education. International Conference on Intelligent Text Processing and Computational Linguistics, 6–27.
Castro-Schez, J. J., Glez-Morcillo, C., Albusac, J., & Vallejo, D. (2021). An intelligent tutoring system for supporting active learning: A case study on predictive parsing learning. Information Sciences, 544, 446–468.
Chassignol, M., Khoroshavin, A., Klimova, A., & Bilyatdinova, A. (2018). Artificial Intelligence trends in education: A narrative overview. Procedia Computer Science, 136, 16–24.
Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. Ieee Access, 8, 75264–75278.
Chen, X., Zou, D., Xie, H., Cheng, G., & Liu, C. (2022). Two Decades of Artificial Intelligence in Education. Educational Technology & Society, 25(1), 28–47.
Chiu, W.-K. (2021). Pedagogy of Emerging Technologies in Chemical Education during the Era of Digitalization and Artificial Intelligence: A Systematic Review. Education Sciences, 11(11), 709.
Ciampi, F., Demi, S., Magrini, A., Marzi, G., & Papa, A. (2021). Exploring the impact of big data analytics capabilities on business model innovation: The mediating role of entrepreneurial orientation. JOURNAL OF BUSINESS RESEARCH, 123, 1–13. https://doi.org/10.1016/j.jbusres.2020.09.023
Clancey, W. J., & Hoffman, R. R. (2021). Methods and standards for research on explainable artificial intelligence: Lessons from intelligent tutoring systems. Applied AI Letters, e53.
Clarizia, F., Colace, F., Lombardi, M., Pascale, F., & Santaniello, D. (2018). Chatbot: An education support system for student. International Symposium on Cyberspace Safety and Security, 291–302.
Colquhoun, H. L., Levac, D., O'Brien, K. K., Straus, S., Tricco, A. C., Perrier, L., Kastner, M., & Moher, D. (2014). Scoping reviews: Time for clarity in definition, methods, and reporting. Journal of Clinical Epidemiology, 67(12), 1291–1294. https://doi.org/10.1016/j.jclinepi.2014.03.013
Cope, B., Kalantzis, M., & Searsmith, D. (2021). Artificial intelligence for education: Knowledge and its assessment in AI-enabled learning ecologies. Educational Philosophy and Theory, 53(12), 1229–1245.
Cox, A. M. (2021). Exploring the impact of Artificial Intelligence and robots on higher education through literature-based design fictions. International Journal of Educational Technology in Higher Education, 18(1), 1–19.
Davidovitch, N., & Eckhaus, E. (2020). The Relationship between Students' Research Motivation, Capacity for Independent Work, and Research Outputs: Defining the Good Advisee Using Natural Language Processing. Journal of Education and Learning, 9(5), 38–44.
Deng, B., & Wu, J. (2021). The Cultivation of Innovation and Entrepreneurship Skills and Teaching Strategies for College Students from the Perspective of Big Data. Arabian Journal for Science and Engineering, 1–14.
Denny, J. C., Bastarache, L., Sastre, E. A., & Spickard III, A. (2009). Tracking medical students' clinical experiences using natural language processing. Journal of Biomedical Informatics, 42(5), 781–789.
Elhajjar, S., Karam, S., & Borna, S. (2021). Artificial intelligence in marketing education programs. Marketing Education Review, 31(1), 2–13.

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.

Erümit, A. K., & Çetin, İ. (2020). Design framework of adaptive intelligent tutoring systems. Education and Information Technologies, 25(5), 4477–4500.

Feng, S., & Law, N. (2021). Mapping Artificial Intelligence in Education Research: A Network-based Keyword Analysis. International Journal of Artificial Intelligence in Education, 31(2), 277–303.

Ferguson, R. (2012). Learning analytics: Drivers, developments and challenges. International Journal of Technology Enhanced Learning, 4(5–6), 304–317.

Fischer, C., Pardos, Z. A., Baker, R. S., Williams, J. J., Smyth, P., Yu, R., Slater, S., Baker, R., & Warschauer, M. (2020). Mining big data in education: Affordances and challenges. Review of Research in Education, 44(1), 130–160.

Gonda, D. E., Luo, J., Wong, Y.-L., & Lei, C.-U. (2018). Evaluation of developing educational chatbots based on the seven principles for good teaching. 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE), 446–453.

Guan, C. (2020). Artificial intelligence innovation in education: A twenty-year data-driven historical analysis. International Journal of Innovation Studies, 14.

Hao, C. (2021). An Exploratory Research on Constructing a Model of Innovation and Entrepreneurship Education for College Students Based on Fuzzy Neural Network Algorithm. Security and Communication Networks, 2021.

Hien, H. T., Cuong, P.-N., Nam, L. N. H., Nhung, H. L. T. K., & Thang, L. D. (2018). Intelligent assistants in higher-education environments: The FIT-EBot, a chatbot for administrative and learning support. Proceedings of the Ninth International Symposium on Information and Communication Technology, 69–76.

Hinojo-Lucena, F.-J., Aznar-Díaz, I., Cáceres-Reche, M.-P., & Romero-Rodríguez, J.-M. (2019). Artificial intelligence in higher education: A bibliometric study on its impact in the scientific literature. Education Sciences, 9(1), 51.

Hodges, J., & Mohan, S. (2019). Machine Learning in Gifted Education: A Demonstration Using Neural Networks. Gifted Child Quarterly, 63(4), 243–252. https://doi.org/10.1177/0016986219867483

Holinska, T., Komarovska, O., Melnyk, O., Pet'ko, L., Shpitsa, R., Sova, O., & Strohal, T. (2019). Cloud technologies in art entrepreneurship education. Journal of Entrepreneurship Education, 22(5), 1–6.

Holzinger, A., Langs, G., Denk, H., Zatloukal, K., & Müller, H. (2019). Causability and explainability of artificial intelligence in medicine. Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, 9(4), e1312.

Hwang, G.-J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Education. Elsevier.

Ifenthaler, D. (2014). Toward automated computer-based visualization and assessment of team-based performance. Journal of Educational Psychology, 106(3), 651–665. https://doi.org/10.1037/a0035505

Ifenthaler, D., Eseryel, D., & Ge, X. (2012). Assessment for Game-Based Learning. In D. Ifenthaler, D. Eseryel, & X. Ge (Eds.), Assessment in Game-Based Learning (pp. 1–8). Springer New York. https://doi.org/10.1007/978-1-4614-3546-4_1

Ifenthaler, D., & Yau, J. Y.-K. (2020). Utilising learning analytics to support study success in higher education: A systematic review. Educational Technology Research and Development, 68(4), 1961–1990.

Ivanytska, N., Tymoshchuk, N., Dovhan, L., Osaulchyk, O., & Havryliuk, N. (2021). EFFECTIVENESS OF DIGITAL RESOURCES IN THE LEARNING MANAGEMENT SYSTEM WITHIN ONLINE EDUCATION OF FUTURE ENTREPRENEURS. 24(4), 9.

Javed, U., Shaukat, K., Hameed, I. A., Iqbal, F., Alam, T. M., & Luo, S. (2021). A review of content-based and context-based recommendation systems. International Journal of Emerging Technologies in Learning (IJET), 16(3), 274–306.

Jena, R. K. (2018). Predicting students' learning style using learning analytics: A case study of business management students from India. Behaviour & Information Technology, 37(10–11), 978–992.
Kaplan, A., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. Business Horizons, 62(1), 15–25.
Karaa, W. B. A., Alkhammash, E., Slimani, T., & Hadjouni, M. (2021). Intelligent Recommendations of Startup Projects in Smart Cities and Smart Health Using Social Media Mining. JOURNAL OF HEALTHCARE ENGINEERING, 2021. https://doi.org/10.1155/2021/3400943
Khanal, S. S., Prasad, P. W. C., Alsadoon, A., & Maag, A. (2020). A systematic review: Machine learning based recommendation systems for e-learning. Education and Information Technologies, 25(4), 2635–2664.
Kim, H. J., Kim, T. S., & Sohn, S. Y. (2020). Recommendation of startups as technology cooperation candidates from the perspectives of similarity and potential: A deep learning approach. DECISION SUPPORT SYSTEMS, 130. https://doi.org/10.1016/j.dss.2019.113229
Klosowski, P. (2018). Deep Learning for Natural Language Processing and Language Modelling. 2018 Signal Processing: Algorithms, Architectures, Arrangements, and Applications (SPA), 223–228. https://doi.org/10.23919/SPA.2018.8563389
Kulik, J. A., & Fletcher, J. D. (2016). Effectiveness of intelligent tutoring systems: A meta-analytic review. Review of Educational Research, 86(1), 42–78.
Li, Y. (2018). An application of EDM: Design of a new online system for correcting exam paper. 2018 13th International Conference on Computer Science & Education (ICCSE), 1–6.
Liang, Y., Wang, H., & Hong, W.-C. (2021). Sustainable development evaluation of innovation and entrepreneurship education of clean energy major in colleges and universities based on SPA-VFS and GRNN optimized by chaos bat algorithm. Sustainability, 13(11), 5960.
Litman, D. (2016). Natural language processing for enhancing teaching and learning. Thirtieth AAAI Conference on Artificial Intelligence.
Liu, M., McKelroy, E., Corliss, S. B., & Carrigan, J. (2017). Investigating the effect of an adaptive learning intervention on students' learning. Educational Technology Research and Development, 65(6), 1605–1625.
Lu, J. (2022). Data science in the business environment: Insight management for an Executive MBA. The International Journal of Management Education, 20(1), 100588.
Luan, H., & Tsai, C.-C. (2021). A review of using machine learning approaches for precision education. Educational Technology & Society, 24(1), 250–266.
Ma, H., Lang, C., Liu, Y., & Gao, Y. (2020). Constructing a Hierarchical Framework for Assessing the Application of Big Data Technology in Entrepreneurship Education. FRONTIERS IN PSYCHOLOGY, 11. https://doi.org/10.3389/fpsyg.2020.551389
Ma, W., Adesope, O. O., Nesbit, J. C., & Liu, Q. (2014). Intelligent tutoring systems and learning outcomes: A meta-analysis. Journal of Educational Psychology, 106(4), 901.
Marín-Marín, J.-A., López-Belmonte, J., Fernández-Campoy, J.-M., & Romero-Rodríguez, J.-M. (2019). Big data in education. A bibliometric review. Social Sciences, 8(8), 223.
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.
McAfee, A., & Brynjolfsson, E. (2012). Big Data: The Management Revolution. 9.
Montebruno, P., Bennett, R. J., Smith, H., & van Lieshout, C. (2020). Machine learning classification of entrepreneurs in British historical census data. INFORMATION PROCESSING & MANAGEMENT, 57(3). https://doi.org/10.1016/j.ipm.2020.102210

Muangprathub, J., Boonjing, V., & Chamnongthai, K. (2020). Learning recommendation with formal concept analysis for intelligent tutoring system. Heliyon, 6(10), e05227. https://doi.org/10.1016/j.heliyon.2020.e05227

Munn, Z., Peters, M. D. J., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. BMC Medical Research Methodology, 18(1), 143. https://doi.org/10.1186/s12874-018-0611-x

Neumeyer, X. (2021). Implementing data analytics into the entrepreneurship curriculum: A course overview. In Annals of Entrepreneurship Education and Pedagogy–2021. Edward Elgar Publishing.

Noroozi, O., Pijeira-Díaz, H. J., Sobocinski, M., Dindar, M., Järvelä, S., & Kirschner, P. A. (2020). Multimodal data indicators for capturing cognitive, motivational, and emotional learning processes: A systematic literature review. Education and Information Technologies, 25(6), 5499–5547.

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. The Internet and Higher Education, 25, 85–95. https://doi.org/10.1016/j.iheduc.2015.02.002

Palasundram, K., Sharef, N. M., Nasharuddin, N., Kasmiran, K., & Azman, A. (2019). Sequence to sequence model performance for education chatbot. International Journal of Emerging Technologies in Learning (IJET), 14(24), 56–68.

Pandey, S., Pandey, S. K., & Miller, L. (2017). Measuring innovativeness of public organizations: Using natural language processing techniques in computer-aided textual analysis. International Public Management Journal, 20(1), 78–107.

Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). Artificial intelligence in education: Challenges and opportunities for sustainable development.

Pérez, J. Q., Daradoumis, T., & Puig, J. M. M. (2020). Rediscovering the use of chatbots in education: A systematic literature review. Computer Applications in Engineering Education, 28(6), 1549–1565.

Pham, M. T., Rajić, A., Greig, J. D., Sargeant, J. M., Papadopoulos, A., & McEwen, S. A. (2014). A scoping review of scoping reviews: Advancing the approach and enhancing the consistency. Research Synthesis Methods, 5(4), 371–385.

Popenici, S. A. D., & Kerr, S. (2017). Exploring the Impact of Artificial Intelligence on Teaching and Learning in Higher Education. Research and Practice in Technology Enhanced Learning, 12. https://doi.org/10.1186/s41039-017-0062-8

Pua, S., Ahmad, N. A., & Khambari, M. N. M. (2021). Identification and Analysis of Core Topics in Educational Artificial Intelligence Research: A Bibliometric Analysis. Cypriot Journal of Educational Sciences, 16(3), 995–1009.

Ragusa, A. T., & Crampton, A. (2018). Sense of connection, identity and academic success in distance education: Sociologically exploring online learning environments. Rural Society, 27(2), 125–142.

Raisch, S., & Krakowski, S. (2021). Artificial intelligence and management: The automation–augmentation paradox. Academy of Management Review, 46(1), 192–210.

Rajabion, L., Wakil, K., Badfar, A., Nazif, M., & Ehsani, A. (2019). A new model for evaluating the effect of cloud computing on the e-learning development. Journal of Workplace Learning.

Rong, G., Mendez, A., Assi, E. B., Zhao, B., & Sawan, M. (2020). Artificial intelligence in healthcare: Review and prediction case studies. Engineering, 6(3), 291–301.

Saha, S. K., & Rao C. H., D. (2022). Development of a Practical System for Computerized Evaluation of Descriptive Answers of Middle School Level Students. Interactive Learning Environments, 30(2), 215–228. https://doi.org/10.1080/10494820.2019.1651743

Salas-Pilco, S. Z., & Yang, Y. (2022). Artificial intelligence applications in Latin American higher education: A systematic review. International Journal of Educational Technology in Higher Education, 19(1), 1–20.

Salas-Rueda, R.-A. (2021). Analysis of Facebook in the Teaching-Learning Process about Mathematics through Data Science. Canadian Journal of Learning and

Technology, 47(2). https://eric.ed.gov/?q=education+machine+learning&id=EJ1324681
Schiff, D. (2021). Out of the laboratory and into the classroom: The future of artificial intelligence in education. AI & Society, 36(1), 331–348.
Schumacher, C., & Ifenthaler, D. (2018). Features students really expect from learning analytics. Computers in Human Behavior, 78, 397–407.
Sedkaoui, S. (2018). How data analytics is changing entrepreneurial opportunities? International Journal of Innovation Science.
Sedrakyan, G., Malmberg, J., Verbert, K., Järvelä, S., & Kirschner, P. A. (2020). Linking learning behavior analytics and learning science concepts: Designing a learning analytics dashboard for feedback to support learning regulation. Computers in Human Behavior, 107, 105512.
Sharma, K., Papamitsiou, Z., & Giannakos, M. (2019). Building pipelines for educational data using AI and multimodal analytics: A “grey-box” approach. British Journal of Educational Technology, 50(6), 3004–3031.
Smith, G. G., Haworth, R., & Žitnik, S. (2020). Computer science meets education: Natural language processing for automatic grading of open-ended questions in ebooks. Journal of Educational Computing Research, 58(7), 1227–1255.
Solano, Q. P., Hayward, L., Chopra, Z., Quanstrom, K., Kendrick, D., Abbott, K. L., Kunzmann, M., Ahle, S., Schuller, M., & Ötleş, E. (2021). Natural Language Processing and Assessment of Resident Feedback Quality. Journal of Surgical Education, 78(6), e72–e77.
Sreelakshmi, A. S., Abhinaya, S. B., Nair, A., & Nirmala, S. J. (2019). A question answering and quiz generation chatbot for education. 2019 Grace Hopper Celebration India (GHCI), 1–6.
Suryavanshi, T., Lambert, S., Lal, S., Chin, A., & Chan, T. M. (2020). Entrepreneurship and Innovation in Health Sciences Education: A Scoping Review. Medical Science Educator, 30(4), 1797–1809. https://doi.org/10.1007/s40670-020-01050-8
Talan, T. (2021). Artificial Intelligence in Education: A Bibliometric Study. International Journal of Research in Education and Science, 7(3), 822–837.
Tang, K.-Y., Chang, C.-Y., & Hwang, G.-J. (2021). Trends in artificial intelligence-supported e-learning: A systematic review and co-citation network analysis (1998–2019). Interactive Learning Environments, 1–19.
Teymurova, V., Abdalova, M., Babayeva, S., Huseynova, V., Mammadov, E., & Islamova, N. (2020). Implementation of Mobile Entrepreneurial Learning in the Context of Flexible Integration of Traditions and Innovations.
Tkachenko, V., Kuzior, A., & Kwilinski, A. (2019). Introduction of artificial intelligence tools into the training methods of entrepreneurship activities. Journal of Entrepreneurship Education, 22(6), 1–10.
Toledo, I., Albornoz, C., & Schneider, K. (2020). Learning analytics to explore dropout in online entrepreneurship education. Psychology, 11(2), 268–284.
Tricco, A. C., Lillie, E., Zarin, W., O’Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., … Straus, S. E. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Annals of Internal Medicine, 169(7), 467–473. https://doi.org/10.7326/M18-0850
Turner, K., & Stough, C. (2020). Pre-service teachers and emotional intelligence: A scoping review. The Australian Educational Researcher, 47(2), 283–305. https://doi.org/10.1007/s13384-019-00352-0
Vabalas, A., Gowen, E., Poliakoff, E., & Casson, A. J. (2019). Machine learning algorithm validation with a limited sample size. PloS One, 14(11), e0224365.
Viberg, O., Hatakka, M., Bälter, O., & Mavroudi, A. (2018). The current landscape of learning analytics in higher education. Computers in Human Behavior, 89, 98–110.
Wang, C., Dong, Y., Xia, Y., Li, G., Martínez, O. S., & Crespo, R. G. (2020). Management and entrepreneurship management mechanism of college students based on

support vector machine algorithm. Computational Intelligence, coin.12430. https://doi.org/10.1111/coin.12430
Wang, Y. (2016). Big opportunities and big concerns of big data in education. TechTrends, 60(4), 381–384.
Winkler-Schwartz, A., Bissonnette, V., Mirchi, N., Ponnudurai, N., Yilmaz, R., Ledwos, N., Siyar, S., Azarnoush, H., Karlik, B., & Del Maestro, R. F. (2019). Artificial intelligence in medical education: Best practices using machine learning to assess surgical expertise in virtual reality simulation. Journal of Surgical Education, 76(6), 1681–1690.
Wu, S., Chen, R., Wei, G., Gao, X., & Huo, L. (2021). Understanding the Impact of Startups' Features on Investor Recommendation Task via Weighted Heterogeneous Information Network. Complexity, 2021.
Xu, C., & Zhang, Z. (2021). The Effect of Law Students in Entrepreneurial Psychology Under the Artificial Intelligence Technology. Frontiers in Psychology, 12.
Xu, J. J., & Babaian, T. (2021). Artificial intelligence in business curriculum: The pedagogy and learning outcomes. The International Journal of Management Education, 19(3), 100550.
Xu, S., Zhang, Q., Lü, L., & Mariani, M. S. (2020). Recommending investors for new startups by integrating network diffusion and investors' domain preference. Information Sciences, 515, 103–115.
Yakubu, M. N., Dasuki, S. I., Abubakar, A. M., & Kah, M. M. O. (2020). Determinants of learning management systems adoption in Nigeria: A hybrid SEM and artificial neural network approach. Education and Information Technologies, 25(5), 3515–3539. https://doi.org/10.1007/s10639-020-10110-w
Yang, L. P., Xu, D. W., & Wang, W. (2014). The Application of Intelligent Agent in Network Platform for Undergraduate's Innovation and Entrepreneurship Education. Applied Mechanics and Materials, 687, 2149–2152.
Yılmaz, F., & Çakır, H. (2021). Learning Analytics and Potential Usage Areas in Education. Learning Analytics, 9.
Zawacki-Richter, O., Kerres, M., Bedenlier, S., Bond, M., & Buntins, K. (2020). Systematic reviews in educational research: Methodology, perspectives and application. Springer Nature.
Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? International Journal of Educational Technology in Higher Education, 16(1), 39. https://doi.org/10.1186/s41239-019-0171-0
Żbikowski, K., & Antosiuk, P. (2021). A machine learning, bias-free approach for predicting business success using Crunchbase data. Information Processing & Management, 58(4), 102555.
Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., Liu, J.-B., Yuan, J., & Li, Y. (2021). A Review of Artificial Intelligence (AI) in Education from 2010 to 2020. Complexity, 2021.
Zhai, X., Yin, Y., Pellegrino, J. W., Haudek, K. C., & Shi, L. (2020). Applying machine learning in science assessment: A systematic review. Studies in Science Education, 56(1), 111–151.
Zhang, Y., & Chan, K. K. (2021). Infusing visual analytics technology with business education: An exploratory investigation in fostering higher-order thinking in China. Innovations in Education and Teaching International, 58(5), 586–595.
Zhou, Y., Huang, C., Hu, Q., Zhu, J., & Tang, Y. (2018). Personalized learning full-path recommendation model based on LSTM neural networks. Information Sciences, 444, 135–152.

5 Effectiveness of virtual team learning in EE: a survey study

5.1 Introduction

EE course is one compulsory module for all enrolled learners in Chinese HEIs, both colleges and universities, with two credits, aiming to cultivate future enterpriser and entrepreneurship identity, entrepreneurship mindset, as well as entrepreneurship professorships (Heinonen & Poikkijoki, 2006; Fayolle & Gailly, 2008). Entrepreneurship and EE, in which educators and learners learn and teach entrepreneurial knowledge, skills, and mindset (Man et al., 2002; Morris et al., 2013), originated in the United States and becomes mainstream as a subject in and outside of business schools throughout the world. Entrepreneurship competence includes sub-competencies from marketing, business, management, economics, and law, as well as other related fields (Sirelkhatim & Gangi, 2015). In comparison with the competence classification by its level, where the focus is on the behavior and process of starting a business, educators, and learners can efficiently teach and acquire entrepreneurship competence related to varied fields. Many studies proved that learners could acquire entrepreneurship competence (Blenker et al., 2014; Marques & Albuquerque, 2020; Nabi et al., 2018). Findings focusing on the outcome or performance of online learning in the context of EE, however, is sparse (Liguori & Winkler, 2020), especially virtual team learning applied in EE at HEIs as well as online learning combined with virtual teams for supporting communication and connectedness among learners (Parrish et al., 2021).

Team learning methods foster competencies of problem-solving and opportunities identification, exceeding entrepreneurial knowledge acquired in tutorials and lectures. This is a favored learning and teaching method in EE, followed by poster reports and engaging students in activities (Pittaway & Cope, 2007; Balan & Metcalfe, 2012). Team behavior affects entrepreneurship learning outcomes and moderates the correlation between entrepreneurship learning motivation and performance (Hytti et al., 2010). Furthermore, team activities provide entrepreneurship cognition, networks of relationships, and practical experience, all of which are essential success factors for (would-be) entrepreneurs (Man, 2007). Besides, team learning, except for F2F EE, is a critical method in online and blended EE. With the announcement of the Action Plan of Education Informatization 2.0 (MEPRC, 2018), Chinese educators integrate information

technology with team learning methods, namely virtual or online team learning applied in online and blended learning settings. In previous research, the concept of a virtual team is mainly discussed in the organization or workplace (Chumg & Huang, 2021; Elyousfi et al., 2021), seldom in the field of formal education. Besides, the virtual team learning method mainly is adopted in the online learning environment (Ismailov & Laurier, 2021; Wen et al., 2015). With the application of the virtual team learning method in a complex and ambiguous blended or F2F EE course, it is necessary to investigate the current developments. Further, we applied the input-mediator-output model to this survey. In detail, considering respondents' demography or characteristics (input), teamwork, taskwork, and ICT (mediators) affect entrepreneurship competence (output).

5.2 Background

5.2.1 Entrepreneurship competence

EE provides courses and activities to develop learners' entrepreneurial knowledge, skills, and attitudes or view towards creating and operating a venture successfully, developing a career, or having a valuable life (Fejes et al., 2019). Entrepreneurship competence slightly differs from management competence that potential entrepreneurs should master. The main difference between them is that management competence focuses on running a venture. In contrast, entrepreneurship competence emphasizes identifying an opportunity for venture creation (Mitchelmore & Rowley, 2010). The competence components are discussed from various aspects. Under the definition of entrepreneurship of the European Commission, the framework of entrepreneurship competence (EntreComp) was published in the year of 2016 and slightly modified in 2018. EntreComp is a broad interpretation that contains idea and opportunity competence (e.g., opportunity recognition and assessment), mobilizing resource competence, and taking into action competence to acquire financial, social, and cultural value. Educators, scholars, and stakeholders need to modify the theoretical framework in light of specific situations and educational activities. This research reviewed additional 11 papers which are published from the year 2001 to 2019 and compared them to EntreComp to understand specific entrepreneurship competencies.

Morris and his colleagues (2013) argued that entrepreneurial competencies involve

entrepreneurship, entrepreneurial, and a series of basic business competencies. Mitchelmore and Rowley (2013) explored entrepreneurial and management competence in their definition. Man et al. (2002) reviewed 12 pieces of literature related to competencies using the area of competency and they reviewed six areas of competency in general. Each area is named by the plural noun of competence. In detail, the conceptual competencies are reflected in the skills of entrepreneurs' behavior, decision-making, taking a risk, and innovation. Strategic competencies are the methods of setting, evaluating, and implementing for a company. Halberstadt and her colleagues (2019) identified five key competencies named by the way of singular nouns. Social competence, namely networks with various stakeholders, is similar to the components of EntreComp. Business competence involves mobilizing resources and adopting firm strategies. Industry-specific competence is closely related to the exploitation of opportunities. Santos and her colleagues (2019) focused on team entrepreneurial competence aspects, encompassing both team and individual levels. They separated innovation and creativity into two individual competencies. Lilleväli and Täks (2017) divided entrepreneurship competence into competencies of the occupation (entrepreneurship) and the individual (entrepreneur). Both consist of conceptual and operational elements. Oosterbeek and his colleagues (2008) separated entrepreneurship competence into seven traits and three skills, while the need for autonomy, the need for power, and flexibility were not shown in the EntreComp. Akhmetshin and his colleagues (2019) emphasized the division of entrepreneurship competence into traits and skills/ competence. In addition, they focused on entrepreneurial knowledge and experience. Sánchez (2013) focused on personality traits, namely self-efficacy, proactiveness, and an inclination toward risk-taking. Mitchelmore and Rowley (2010) built a competence framework that narrows entrepreneurship competence as the identification of entrepreneurial opportunities, including management competence, human relations competencies, and conceptual/ relationship competencies. Baum and his colleagues (2001) analyzed from traits and general competence of Chief Executive Officers. By comparison with Man et al. (2002), Lans and his colleagues (2014) adopted a broader interpretation of entrepreneurial competence, e.g., financial literacy and economic literacy are included, and this classification has been structuralized. The 12 literature sources were compared to the

EntreComp framework proposed by European Commission. Figure 5-1 shows the calculated ratio of 15 sub-competencies.

Competence	Literature											
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Opportunities recognition	+	+	+	+	+				+		+	+
Creativity	+	+					+		+	+	+	+
Perseverance	+				+	+	+			+		+
Mobilizing resource/organisation	+			+		+				+		+
Finance			+			+						+
Mobilizing human resource		+	+	+	+	+	+					+
Learning through experience			+			+						+
Tolerence of ambiguity						+						+
Management		+	+	+	+	+			+		+	+
Taking the initiative								+	+		+	+

Literature source: (C1). Morris et al., (2013); (C2). Man et al. (2002); (C3). Mitchelmore & Rowley (2010); (C4). Baum et al. (2001); (C5). Mitchelmore et al. (2014); (C6). Lilleväli & Täks (2017); (C7). Oosterbeek et al. (2008); (C8). Sánchez (2013); (C9). Akhmetshin et al. (2019); (C10). Santos et al. (2019); (C11). Halberstadt et al. (2019); (C12). Bacigalupo & O'Keeffe (2018).

Figure 5-0-1 The calculated ratio of 15 sub-competencies

Table 5-1 Descriptive statistics of 11 items of entrepreneurship competence

Section	Item	Mean	Std. deviation
Position	PO_FINANCE	5.30	1.145
	PO_MANAGE	5.48	1.012
	PO_RESORCE	5.33	1.134
	PO_OPPORTUNITY	5.17	1.297
	PO_ACTION	5.35	1.113
	PO_EXPERIENCE	5.56	0.980
	PO_NETWORK	5.57	1.090
Personality traits	TR_SELF-EFFICACY	5.37	1.088
	TR_PERSEVERENCE	5.49	1.084
	TR_RISK	5.65	1.007
	TR_CREATIVITY	5.40	1.128

Due to the lack of practical experience when applying EntreComp (Czyzewska &

Mroczek, 2020), this study analyzes entrepreneurship competence on basis of this framework. We did not consider the low ratios of *ethical & sustainable thinking and Vision*. *Valuing ideas* was combined with *opportunity recognition. Mobilizing others* and *mobilizing resources* were combined as *mobilizing resources*. Based on the classification of competence introduced by Lilleväli and Täks (2017) and Akhmetshin et al. (2019), this study incorporated 11 sub-competencies (Table 5-1) in two sections: *position* and *personality traits*. The *position* includes *opportunity recognition, mobilizing resources, taking the initiative*, *finance, learning through experience, social network, and management.* The *personality traits* contain *perseverance, self-efficacy, coping with ambiguity& risk actively,* and *creativity*.

5.2.2 Virtual team learning

Virtual teams mainly use ICT to facilitate the completion of task goals with teammates (Maznevski & Chudoba, 2000) in schooling environments and workplaces (Ismailov & Laurier, 2021; Laitinen & Valo, 2018). Here the definition of a virtual team is synonymous with an online, remote, or distance team/group. Virtual team learning is introduced into a virtual learning setting to promote the distributed learners' socialization through asynchronous/synchronous and verbal/nonverbal methods that contain email, video, audio, and multi-media social networking software and devices. Although learners returned to school with the uncertain outbreak of Coronavirus, educators and their stakeholders need to prepare for the unclear future or crisis through online learning (Ratten, 2020).

Teams or virtual teams reflect a complex system (Ilgen et al., 2005), including three central elements: *teamwork*, *taskwork*, and ICT (Müller & Antoni, 2020; Holtkamp et al., 2015; Warkentin & Beranek, 1999). In the current study, the application of ICT for communication and idea exchange is a basic requirement for teammates (Holtkamp et al., 2015). Because online and blended learning environment lacks opportunities for connection and communication, ICT is applied in a virtual team for communication and task completion in the process of learning and teaching, e.g., Facebook (Pittaway & Edwards, 2012), Twitter (Price et al., 2018), and podcast (Marques & Albuquerque, 2020) were utilized in EE courses. Taskwork and teamwork are slightly different concepts in the research of a team. Scholars usually take them as two similar facets of the team and analyze them together. While there is a difference between taskwork and teamwork in

the interaction (Nissen et al., 2014). Simply speaking, teamwork is "collaboration" and taskwork means "cooperation" (Crawford & LePine, 2013). Specifically, taskwork focuses on task activities and devices to complete a specific task. While teamwork emphasizes teammates' collaboration, interaction or relationship, strength, and weaknesses (Fisher, 2014; Müller & Antoni, 2020).

Based on the theory of team compilation and performance (Kozlowski et al., 1999) and the input-mediator-output-input (IMOI) model of the team effectiveness (Ilgen et al., 2005; Rosero et al., 2021), this study places emphasis on one period, namely input-mediator-output (IMO). *Mediator* expanded the number of variances by replacing *process* (Ilgen et al., 2005). The theory framework contains three parts and is shown in Figure 5-2, accompanying the main hypotheses of this study.

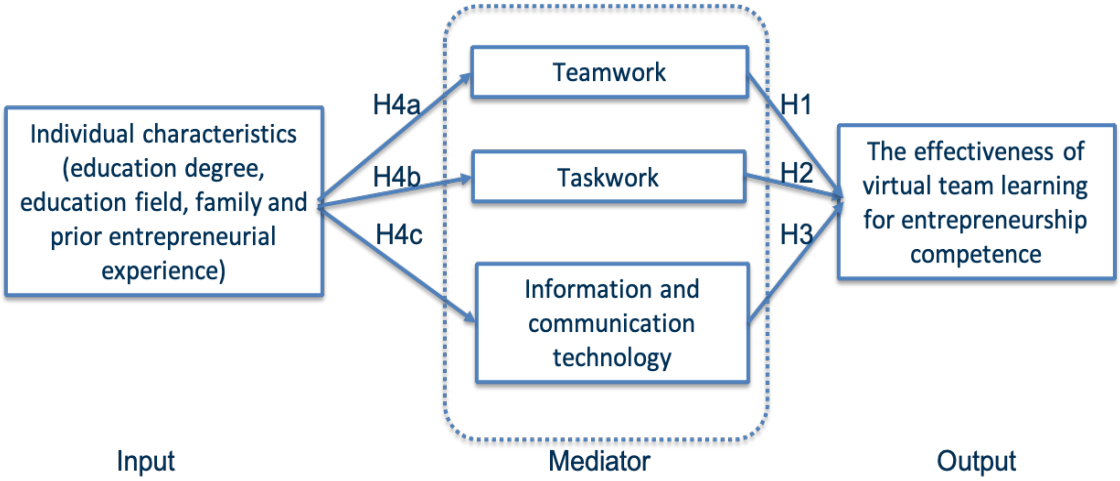

Figure 5-2 The theoretical framework and hypotheses

Among the individual characteristics included in the *input* are gender, education degree, the field of education, family entrepreneurial history, and the learner's prior entrepreneurial experience. ICT, virtual teamwork, and taskwork are mediators. The output or performance section argued the performance of virtual team learning for entrepreneurship competence.

5.2.3 Hypotheses

The improvement of cognitive competence requires interaction between teachers and learners (Agudo-Peregrina et al., 2014). While entrepreneurial educators focus on constructivist learning theory and "learning by doing" by providing EE programs or project (Bell & Bell, 2020; Hytti et al., 2010; Taylor & Thorpe, 2004). Little, however, is known about the attitude toward the effectiveness of online learning from the students'

side (McConnell, 2018), especially in EE. Both teamwork and taskwork have distinct functions for entrepreneurship competence and their correlation needs to be compared. Additionally, the effectiveness of technology applied in a virtual team is discussed below.

Problem-based learning (Santateresa, 2016; Igwe et al., 2021), project-based learning (Arias et al., 2018), and program-based learning (Duval-Couetil & Shartrand, 2016), all of which require team-based learning activities, bring with collaboration and cooperation. In other words, the mentioned methods are different organizational forms of team tasks. Taskwork is one critical element of team learning, providing diverse activities and tasks to acquire entrepreneurial skills and mindsets. Two types of virtual tasks are common. One is putting tasks into virtual environments, which is in the primary phase, supported by cutting-edge technologies (van Ginkel et al., 2019; Wang et al., 2020). An example is the completion of a written process in a virtual environment (Mayordomo & Onrubia, 2015). Another example is gamers discovering venture opportunities with other avatars and earning virtual currency in Second Life serious games. The other is that after completing F2F tasks of teams, learners might submit an authentic business plan or present the result in a digital way. The effect of virtual tasks is complicated. Previous research showed online activities can facilitate learners' knowledge and skills (Hart et al., 2019; Pei & Wu, 2019). In detail, the feedback and formal evaluation of virtual team exercises are positive in the management education (Clark & Gibb, 2006). Similarly, virtual tasks probably affect the performance of virtual team learning for entrepreneurship competence. Hence, we assumed this hypothesis:

> **Hypothesis 1.** Virtual taskwork has a positive effect on the effectiveness of virtual team learning for entrepreneurship competence.

Further, teamwork, team relationship, or social network emerges amongst entrepreneurial teammates who are both learning partners and "co-founders". Teammates with diverse backgrounds have shared learning goals and work on an entrepreneurial project in a democratic, trust, and safe environment (Harms, 2015). Teamwork is effective for starting a business (Warhuus et al., 2017). Both taskwork and teamwork have been illustrated in a F2F environment (Lepine et al., 2000). Regarding the virtual team, taskwork and teamwork are much more complicated than offline. A friendly teamwork or team relationship facilitates teammates to improve performance

and team satisfaction as well as avoiding conflicts and freeriding (De Dreu & Weingart, 2003; Scott et al., 2019). The study proved the virtual team relationship is as good as that in the F2F environment (Rogers & Lea, 2005). Additionally, it partly overcomes distributed course attendees' feelings of disconnectedness and separation (Parrish et al., 2021). Hence, virtual team relationships might affect the effectiveness of virtual team learning for entrepreneurship competence. The correlation between virtual team relationships and virtual team learning was assured below:

> **Hypothesis 2.** Virtual teamwork has a positive effect on the effectiveness of virtual team learning for entrepreneurship competence.

In addition, ICT impacts virtual team learning (Carlson et al., 2013; Bell & Kozlowski, 2002). In an EE setting, the utilization of this technology is a moderator between venture creation intention and risk (Bandera et al., 2018). Web 2.0 technology can increase absorptive capacities which has a positive effect on the social entrepreneurship behavior (García-Morales et al., 2020). At present, the function of educational technology is expanded, such as sharing resources (the version of the text, audio, and video), posting assignments, and exchanging ideas on forums or in social media groups. Learners and instructors are in the same social software networking groups such that they inspire each other through discussing and communicating. Meanwhile, each team has its own social media collaborative group to discuss and complete tasks together. Social media provide more possibilities for connection and learning how to collaborate with others when they are distributed. In addition, as a result of the significance of the practice and real-life experience for entrepreneurs (Ratten, 2020), learners obtain competencies of entrepreneurship through not only listening and understanding but also applying and acting when they complete team tasks. Accordingly, here is Hypothesis 3.

> **Hypothesis 3.** ICT has a positive effect on the effectiveness of virtual team learning for entrepreneurship competence.

Finally, this study takes into consideration individual characteristics or learners' demographic backgrounds that affect team processes and performance (Entin & Serfaty, 1999), without considering characteristics of groups. In light of previous academic studies and teaching experience, gender, education degree (Paray & Kumar, 2020), education field (Pittaway & Edwards, 2012), family entrepreneurial history (Wadhwa &

Aggarwal, 2009, Nowiński et al., 2019), and prior entrepreneurial experience (Ngoc Khuong & Huu An, 2016; Mathews & Moser, 1995) influence entrepreneurial intention and learning. Hence, this study assumed individual affect virtual taskwork, virtual teamwork, and ICT separately.

Hypothesis 4a. Individual characteristics (gender, education degree, education field, family entrepreneurial history, and prior entrepreneurial experience) affect virtual taskwork.

Hypothesis 4b. Individual characteristics (gender, education degree, education field, family entrepreneurial history, and prior entrepreneurial experience) affect virtual teamwork.

Hypothesis 4c. Individual characteristics (gender, education degree, education field, family entrepreneurial history, and prior entrepreneurial experience) affect ICT.

5.3 Methodology

Considering the robust correlation between self-perception, as established by Mitchelmore and Rowley (2010), the primary data source for the present study was derived from the perceptions of the participants.

5.3.1 Participants

A convenience sampling method was adopted. The four responding teachers applied virtual teams to their EE courses from three different level HEIs (a top-tier university, a common university, and two vocational and technology academic institutes), all of which are located in the Yangtze River Delta region in China. They distributed the online questionnaire survey to their enrolled students. In the introduction letter of survey questions, the authors emphasized that someone who had joined/was working in social media groups. Initially, 707 respondents from HEIs completed the online survey and 682 valid responses were collected. Excluding two outliers (two and 100 years old) and seven missing responses or filled names, *Min* = 16, *Max* = 44, *M* = 19.68 years old, *SD* = 1.717. Education degree: senior school or under (.6%), three years college or vocational and technical education (38.3%), bachelor (60.3%), and master or over (.9%). The science field contains social science (19.1%), nature science (17.7%), applied science (37.0%), formal science (13.2%), and humanities (13.0%). 27.7% of respondents have a history of family entrepreneurs and 62.3% do not have this history. 9.2% of respondents

have entrepreneurial experience and 91.8% do not.

5.3.2 Design and instrument

The survey was designed and displayed using Microsoft Form by forwarding the link with a specific explanation in WeChat groups. WeChat is mainly for connecting with entrepreneurial teachers and learners, which is the most convenient and popular communication tool for collaboration with Chinese scholars and responses as a result of the number of monthly active accounts reaching 1.20 billion in the first quarter of 2020 (CAICT, 2020). This online survey outline was designed by researchers, including demography, 11 entrepreneurial competencies, and three components of the virtual team. Concerning demographic questions, age was excluded and we considered gender, educational field, education degree, history of family entrepreneurs, and prior entrepreneurial experience. Therefore, researchers set five background and demographic questions. Then 11 items related to competencies, seven related virtual team learning, and one alternative question to test the hypotheses mentioned above. Researchers designed seven items related to the entrepreneurial *position*, e.g., "I can discover possible entrepreneurial opportunities" and four are related to *personality traits*, e.g., "I believe I can successfully start a valuable business." Two items of taskwork (TA_EASE and TA_STRATEGE), two items of teamwork (TE_TRUST and TE_DURATION), and the last three of ICT (ICT_VARIOUS, ICT_FREQUENCY, and ICT_PROFICIENCY) tested virtual team learning separately, e.g., "I like tasks with moderate difficulty", "After completing the group task, I still contact with the group members", and "When I attend EE courses, I use ICT to communicate and discuss with teammates every time". A seven-point Likert scale ranging from 1 = totally disagree to 7 = totally agree was applied to get structured answers. Adoption of this scale avoids Confucianism that emphasizes the *Golden mean*, not too much and too little (Niemiec, 2019), which might lead Chinese respondents to prefer choosing the middle answer. Considering further discussion or collaboration, the alternative questions are open and optional to fill in *If you want to further join the research, please leave your e-mail address*.

5.3.3 Procedure

When the first version of the survey was finished, four experts of education technology and two teachers from EE provided feedback toward the content validity. The authors modified the survey and started a pilot survey among 72 participants who had

experience with EE and were members of the same EE WeChat groups. Then the survey was administered on a larger scale from 28 April to 30 June 2021. The two educators distributed the online survey to their students across their universities (one is a top-ranked university and one is a normal college). Additionally, students from three higher vocational education colleges filled the question. The research team cleaned the data.

5.3.4 Data analysis

The data analysis adopted IBM SPSS 28 software, which is a statistics analysis appropriate for social science. H1, H2, and H3 were tested using linear regression, with three elements of the virtual team as the independent variables and the performance of virtual team learning for entrepreneurship competence as a dependent variable. Analysis of variance (ANOVA) was adopted to test H4a, H4b, and H4c.

5.4 Result

An alpha level of .05 was used for statistical tests. Except for demographic items, the research adopted the rest to factor analysis. Kaiser-Meyer-Olkin Measure of Sampling Adequacy value is .959 > .9, and Bartlett's test of sphericity significance is .000 < .05. These items are quite suitable for exploratory factor analysis. Analysis used correlation matrix; extraction method is principal component analysis; rotation method is varimax with Kaiser Normalization. Therefore, three factors with 11 competencies/items remained: Factor 1 *personality traits* including four items, Cronbach's alpha = .879; Factor 2 *position* includes seven items, Cronbach's alpha = .931; Factor 3 virtual team contains seven items, Cronbach's alpha = .933; The alpha value of the overall formal items (except demographic questions) is .969, which proved all had an adequate level of inter-item reliability. The cumulative contribution rate of the interpretable variance of the survey sample is 76.02%.

Hypothesis 1-3

The results of Hypothesis 1-3 are shown in Table 5-2. In general, the perception of *personality* is higher than the *position* in Hypothesis 1-3 from virtual taskwork, teamwork, and ICT aspects.

Table 5-2 The results of Hypothesis 1-3

Hypothesis	Item	F (3.84)	P
Hypothesis 1	VT_IDEA	376.566	.000

	VT_RESOURCE	205.163	.000
	VT_ACTION	333.020	.000
	VT_EFFICIENT	298.091	.000
Hypothesis 2	VT_IDEA	164.888	.000
	VT_RESOURCE	189.439	.000
	VT_ACTION	176.655	.000
	VT_EFFICIENT	124.039	.000
Hypothesis 3	VT_IDEA	328.400	.000
	VT_RESOURCE	305.040	.000
	VT_ACTION	350.044	.000
	VT_EFFICIENT	244.566	.000

Descriptive statistics have been calculated for the ease of task (TA_EASE, *M* = 5.39, *SD* = 1.089), for strategy of completing task (TA_STRATEGE, *M* = 5.43, *SD* = 1.019), and for taskwork (*M* = 5.408, *SD* = 1.003). To investigate whether virtual taskwork has a positive on the entrepreneurship competence (the *position* and *personality traits*), Linear Regression was applied, yielding results of *position*, *F*(1, 680) = 1114.107, *B* = .710, adjusted R^2 = .620, $p < .001$, and *personality traits*, *F*(1, 680) = 1287.566, *B* = .740, adjusted R^2 = .654, $p < .001$. Virtual taskwork positively affects both the *position* and *personality traits*. Therefore, Hypothesis 1 is accepted.

Descriptive statistics have been calculated for trust each other (TE_TRUST, *M* = 5.63, *SD* = 1.028), the duration of the team relationship (TE_DURATION, *M* = 5.53, *SD* = 1.069), and teamwork (*M* = 5.577, *SD* = .981). To reveal the relationship between virtual teamwork and the effectiveness of entrepreneurship competence, Linear Regression was used. The result showed virtual teamwork positively affects the *position*, *F* (1, 680) = 1357.979, *B* = .753, adjusted R^2 = .666, $p < .001$, and *personality traits*, *F* (1, 680) = 1674.032, *B* = .789, adjusted R^2 = .711, $p < .001$. Virtual teamwork or team relationship significantly affects EE in terms of the position and personality traits. Therefore, Hypothesis 2 is accepted.

Various technologies (ICT_VARIOUS, *M* = 5.55, *SD* = 1.015), the frequency of usage of ICT (ICT_FREQUENCY, *M* = 5.42, *SD* = 1.095), the proficiency of usage of ICT (ICT_PROFICIENCY, *M* = 5.46, *SD* = 1.091), and ICT (*M* = 5.475, *SD* = .963) have been calculated. Linear Regression revealed that ICT are positive on the *position F* (1, 680) = 973.811, *B* = .721, adjusted R^2 = .691, $p < .001$ and *personality traits F* (1, 680) = 1520.808,

B = .792, adjusted R^2 = .588, p < .001. ICT positively affects entrepreneurship competence: the *position* and *personality traits*. Therefore, Hypothesis 3 is accepted. Through multiple linear regression analysis with virtual teamwork, taskwork, and ICT as independent variables. *Position* and *personal traits* as the dependent variable. In equation (1), p = .000 < .05, adjusted R^2 = .760 and in equation (2), p = .000 < .05, adjusted R^2 = .828 without collinearity in both equations.

$$Y_{position} = 0.398x_{TE}+0.301x_{TA}+0.177x_{ICT} \quad (1)$$

$$Y_{traits} = 0.374x_{TE}+0.258x_{TA}+0.300x_{ICT} \quad (2)$$

Hypothesis 4a-c

The results of Hypothesis 4a-c employing one-way ANOVA are shown in Table 5-3.

Table 5-3 The results of Hypothesis 4a-4c using ANOVA

Hypothesis	Characteristic	F	Sig.
Hypothesis 4a	Gender	1.435	.231
	Education degree	2.807	.039
	Education field	.393	.814
	Entrepreneurial family history	6.807	.009
	Entrepreneurial experience	2.864	.091
Hypothesis 4b	Gender	4.174	.041
	Education degree	1.844	.138
	Education field	.335	.854
	Entrepreneurial family history	6.432	.011
	Entrepreneurial experience	3.401	.066
Hypothesis 4c	Gender	5.437	.020
	Education degree	4.246	.006
	Education field	.678	.608
	Entrepreneurial family history	6.077	.014
	Entrepreneurial experience	2.770	.096

ANOVA was used to test for the differences of demographics (gender, education field, entrepreneurial family background, education degree, and entrepreneurial experience) on virtual taskwork. Female and male students are not different on the perception of

virtual taskwork for EE, F (1, 680) = 1.435, p = .231. Different education field could not affect participants' opinion, F (5, 677) = .393, p = .814. Moreover, whether learners' family has their own business or not, which would not influence their opinion on virtual taskwork, F (1, 680) = .818, p = .366. However, their own entrepreneurial experience affected their attitudes towards virtual taskwork, F (1,680) = 6.807, p = .009. Further, the higher the education degree of learners, the higher comment on virtual taskwork, F (4, 678) = 2.807, p = .039. Therefore, Hypothesis 4a is accepted for the education degree and prior entrepreneurial experience and rejected for gender, education field, and entrepreneurial family background.

Additionally, ANOVA was used to test for the differences in demographics on the perception of virtual teamwork. Higher or lower education degrees could not influence the perception of virtual teamwork, F (4,678) = 1.844, p = .138. Additionally, participants from social science, natural science, and the other three fields had similar attitudes towards virtual teamwork in this survey, F (5,677) = .335, p = .854. And learners with or without entrepreneurial experience were not different on virtual teamwork, F (1,680) = 3.401, p = .066. However, female participants rated higher than those of males, F (1,680) = 4.174, p = .041. Further, learners without entrepreneurial family backgrounds rated virtual teamwork higher than others, F (1,680) = 6.432, p = .011. Therefore, in Hypothesis 4b, gender and entrepreneurial family background are accepted, and education field, education degree, and entrepreneurial experience are rejected.

Further, ANOVA was used to test for the differences of demographics on the perception of ICT. There was no significant difference between education fields and the perception of ICT, F (5,677) = .678, p = .608. In addition, the entrepreneurial experience was not an impact variable at this point, F (1,680) = 2.770, p = .096. However, gender impacted the attitudes of participants, F (1,680) = 5.437, p = .020. Moreover, their entrepreneurial family background affected the perception, F (1,680) = 6.077, p = .014, and the higher education degree, the higher rated, F (1,680) = 4.246, p = .006. Therefore, in Hypothesis 4c, gender, entrepreneurial family background, and education degree affect ICT. The education field and prior entrepreneurial experience are rejected.

5.5 Discussion

F2F team learning is still mainstream in Chinese HEIs, although Chinese top universities create MOOCs on iCourse and XuetangX. Common pedagogical practice for virtual team learning is combined with the F2F environment to develop further amongst learners enrolled in HEIs. This study assumed that the performance of virtual team learning was affected by virtual teamwork, taskwork, and ICT separately, as well as their interactional impacts. Additionally, the probable influence of five demographic factors on virtual teamwork, taskwork, and ICT was assessed.

5.5.1 Findings of virtual taskwork and the impact of demography on it

The completion of virtual tasks lacks guidance from instructors in person and practical learning experience. At the same time, entrepreneurial tasks require capacities containing business administration, finance, law, and other related knowledge and skills, which highly requires participants professional in both their specific areas (depth) and other disciplines (width), namely T-shaped talents or enterprisers (Demirkan & Spohrer, 2015; Chan et al., 2020). This is the reason that educators provide support for would-be entrepreneurs to learn and rather not complete tasks alone when they lack experience in a virtual learning environment. Findings indicate that virtual taskwork impacts the effectiveness of EE in terms of entrepreneurial *position* and *personality traits*.

From the area of *position*, would-be entrepreneurs should acquire competencies of finance, management, learning from experience, social networking, identifying opportunities, and taking action. Entrepreneurial opportunity recognition is a critical and complicated competence for (would-be) entrepreneurs. Identifying entrepreneurial opportunities needs three antecedents: schematic (or mental frameworks) richness, schematic association, and schematic priming, coming from entrepreneurial expertise, practice, and intention (Valliere, 2013). Furthermore, alertness to opportunities sourcing from prior knowledge or information related to a specific industry or target customers simulates the opportunities identification (Baron, 2006). Moreover, spotting an opportunity requires the competence of innovation or creativity facilitated through orchestrating resources (Andersén & Ljungkvist, 2021). Although learners and instructors expend much effort and attention to identify opportunities, the learning result is still lower than expected on alertness to opportunities of starting a business. The minority understands the complexity of both

mastering industry trends and knowing the real needs of customers. Mobilization of resources, such as human, capital, or information resource, extends boundaries when completing tasks in a virtual team with the benefits of fewer costs and time than in the F2F team (Barnowska & Kozaryn, 2018). It has been proved that taking the initiative of entrepreneurial ideas to integrate resources is complicated. For one thing, finding the clients' real needs should insight into the internal and external marketing environment, e.g., Porter's five forces model. For another, although learners come up with an ideal entrepreneurial project, being the early stage of starting a business, the nascent entrepreneurs need assistance from capital, technology, or human which predicts the gestation activities of firms (Davidsson & Honig, 2003). While nascent entrepreneurs lack social and capital resources, compared with the experienced. Teammates apply knowledge of management and finance to collective tasks, better understanding and remembering basis on Bloom's Taxonomy. And solving problems inspires new ideas, especially when instructors encourage learners to apply new methods/tools, and another perspective (Guest & King, 2004). Therefore, virtual taskwork can facilitate the entrepreneurial competence of *position*, the sub-entrepreneurial competency. *Personality traits* related to entrepreneurs are hard to acquire because of stability in a short period. This study showed virtual taskwork statistically affects these traits, namely perseverance, self-efficacy, coping with ambiguity and risk, and creativity separately. For example, the completion of intentional assignments develops self-confidence and tenacity, leading to self-efficacy and perseverance (Olson, 2017). Educators assign team tasks for learners, considering learners' learning needs and current learning status. During the process of completing virtual taskwork, learners know themselves and their teammates in depth, their performance improving through (individual and team) reflection and learning from others (Decuyper et al., 2010).

The other findings are the effectiveness of the demographic items on the perception of virtual taskwork. With different education degrees and with/without entrepreneurial experience, participants rated differently on virtual teamwork. To complete entrepreneurial tasks, teammates need to master knowledge and competence of specific disciplines that learners with higher education perform better than the less educated. Students with the background of family businesses learned from observation and are directly or indirectly influenced by family experience when they adopt business

strategies.

5.5.2 Findings of virtual teamwork and the impact of demography on it

Teamwork or team relationship in a virtual team environment comes from various team activities organized by course designers. These activities facilitate teammates' sharing cognition or knowledge, valuable for team performance or effectiveness, explained by shared mental models theory (Cannon-Bssowers & Salas, 2001). Then a cohesive team is formed through a trust and friendly team relationship (Salas et al., 2015). Team cohesion and team openness is positively related to team performance, moderated by the experience of communication media in a virtual team (Carlson et al., 2013). Hence, teamwork or team relationship has a causal association with the effectiveness of team learning. In this survey, virtual teamwork impacts the effectiveness of EE in terms of entrepreneurial *position* and *personality traits* in this study.

When teammates have close relationships, compared to *personality traits*, competencies related to the entrepreneurial *position*, namely learners might acquire competencies of finance, management, learning from experience, social networking, opportunities identification, and taking action, are less impacted (see Table 5-2). It might be that team cohesion and team personality impact directly the *personality traits* of teammates, indirectly affecting entrepreneurial positional competencies through emotion and motivation (Molleman, 2005). In the *position* section, both cohesion and openness of the team are vital for sharing information and exchanging ideas to identify entrepreneurial opportunities and mobilize resources In an entrepreneurial virtual team. When adopting a virtual team method, participants should pay attention to the relationship amongst teammates utilizing increasing interest, solving conflicts, and improving trust amongst remoted teammates (Newman & Ford, 2021). The relationship is possible to extend their social networking across the world. Following the good construction of team relationships, teammates will share more personal information and further conversation. In a friendly environment, learners will unconsciously learn from peers, and their attitudes and behaviors influence the team atmosphere conversely. Nevertheless, one feature of a friendly team atmosphere is supporting each other, all for one and one for all (Baruch & Lin, 2012). The perseverance of teammates might promptly increase in a friendly and close environment. Teammates are open, trust, and have a cohesion (Goldstein & Gafni, 2019), which facilitates the completion

of collaborative tasks and the improvement of the learning (Xie et al., 2019). In the *traits* section, self-efficacy is a synonym of perceived control. Team cohesion positively affects perceived control in the online environment (Zhao et al., 2021). Thus, teamwork influences self-efficacy in a virtual team. Risk-taking or tolerance of ambiguity is the result of perceived control. *Creativity* comes with an environment where everyone shows their opinions freely and respects others' ideas. Therefore, teamwork facilitates the *position* and *personality traits* of entrepreneurship competence.

The influence of demographic factors is discussed here. Around two-thirds (62.3%) of respondents have no entrepreneurial family background that might be more beneficial for entrepreneurial practice in real marketing. In comparison, academic or school settings provide robust area knowledge, focusing on basic entrepreneurial knowledge and skills. Therefore, family education might affect entrepreneurial intention and practical competence, leading to better team relationships. When female learners act in the role of manager, they facilitate collaboration in a team and the gender composition of online learning impacts the team performance (Song et al., 2015; Beddoes & Panther, 2018). Kariv et al. (2019) studied that experienced entrepreneurial learners prefer academic projects for learning knowledge and nascent/wanna-preneurs might choose non-academic projects that focus on funding, marketing, etc., this study did not find entrepreneurial experience affect virtual teamwork/team relationship, as well as education degree and education field.

5.5.3 Findings of ICT and the impact of demography on it

Distributed teammates share opinions and experiences through threaded asynchronous discussion (Warkentin & Beranek, 1999; Jeong & Hmelo-Silver, 2016) and synchronous ideas exchange, which contributes to task completion and close team relationship. It is significantly different between ICT and the performance of virtual team learning in both *position* and *traits* section, being one critical aim of this survey.

In detail, the social media group provides asynchronous (text, audio, or recorded video) or synchronous (real audio or video) methods to successfully discuss and exchange ideas for completing missions, which are probable to build a new social network. During the process, teammates' or peers' opinions probably inspire others (brain-storming), broadening their minds and presenting innovative views. Classifying misunderstandings, helping struggling teammates, and reemphasizing shared goals happen in operating

synchronous meetings (Olson-Buchanan et al., 2020). Additionally, ICT devices can store and access all dialogues, learning materials, and other documents permanently and traceable on every participant's device in case of compliance with data protection regulations. Leaners and educators instantly review all recorded course-related information to increase the frequency and possibility of communication and learning success. On the one hand, social media software can merge with other software. For example, business canvas applications can plug into the social media group. ICT provides more connective and collaborative possibilities because of the two features of usefulness and ease of use (Venkatesh & Davis, 2000). On the other hand, the collaboration and relationship among teammates are close so that the learning atmosphere is more supportive and friendly. The intrinsic and extrinsic learning motivation of learners, as well as their perseverance, are facilitated. Except for *perseverance*, other *personality traits* related to entrepreneurship competence also can be positively affected. For example, Web 2.0 and 3.0 combine participants deeply and bring new possibilities of *creativity*. The technology effortlessly combines with other cutting-edge technologies to enhance the quality of cooperation and even closer team relationships. Hence, ICT impacts the effectiveness of virtual team learning in EE.

The findings of demography proved that entrepreneurial family backgrounds, gender, and education degree impact the perception of ICT in EE. Participants with entrepreneurial family backgrounds commented lower on the effectiveness of ICT. Luo et al. (2012) proved that business ties or Guanxi ties are indispensable for organizations in Mainland China than overseas. In the Chinese business environment, business ties or Guanxi ties are constructed by basing on fair exchanges and the principle of reciprocity. Enterprisers mainly cooperate with family members, good friends, and acquaintances on the periphery (Burt & Burzynska, 2017). In other words, their connection emerged from practical business or trade-based activities which are challengeable to acquire through applying virtual tools (Turnbull et al., 2021). With family entrepreneurial backgrounds, participants have more social ties that provide resources and the latest industry information. It has been investigated that ICT is beneficial for entrepreneurial activities. For example, ICT provides connections and links for female entrepreneurs with stakeholders in developing countries (Venkatesh et al., 2017). Participants with family members having a business have more methods and resources to acquire

entrepreneurship competence than others. The female' ICT literacy is slightly higher than the male (Siddiq& Scherer, 2019), which can explain the reason for the difference of comments. Universities students gave higher than three-year college. The higher education, the higher evaluation (Paray & Kumar, 2020). In addition, the function of ICT is a communication tool that demands combining with other approaches. Hence, ICT undercovers that educators can advance the acceptance of virtual team learning through attaching technologies in EE courses.

5.5.4 Findings on the correlation of three factors

Multiple linear regression analysis explained how virtual taskwork, teamwork, and ICT might operate or affect the performance of virtual team learning in EE together. This study attempts to explore the interrelationships between the three elements of virtual team learning. Based on the Correlation Coefficient, technology possessed a higher correlation with both teamwork (.758) and taskwork (.753) than the correlation between teamwork and taskwork (.722) (see Equations 1 and 2). Taskwork and teamwork are two sides of team activities or behaviors in a F2F learning environment. While online or blended learning environment heavily depends on technical tools or devices to discuss and communicate. When to use ICT and how to use it affect team relationships (Parrish et al., 2021). When learners are accustomed to and have sufficient skills in information technology, they probably accept virtual team learning quickly, complete tasks successfully and efficiently (taskwork), leading to imitative team learning relationships with teammates (teamwork). Hence, the influence of technology needs to be considered when adopting virtual team learning.

In this study, virtual teamwork is the most important factor in both equations of *personality traits* and *position*. In other words, the performance of virtual team learning mainly depends on the relationship among teammates for discussion and task completion. In addition, social media software is taken as a learning management system to distribute documents and announce related information in EE courses. This function of social media was especially adopted by many Chinese educators who did not or seldom apply official learning management systems to their daily teaching, learning, and classroom management. One reason is that educators need to spend much time on virtual groups, especially in large classes with over 40 students (McConnell, 2018). And the student-teacher ratio in Chinese HEIs offering

undergraduates was 17.4:1 in 2018 (MEPRC, 2019). ICT saves time for educators by organizing common questions and queries, improving learners' well-being and academic performance (Samad et al., 2019).

5.6 Conclusion and further research

Under the teacher-centered circumstances and lack of learners' independence (Yin et al., 2014), the approach to virtual team learning in campus-based universities is rarely adopted. Scholars, educators, and their stakeholders need to get feedback and collect data from instructors and learners. The team learning method encourages learners to share information and resource (Gikas & Grant, 2013). Taskwork, teamwork, and ICT are three critical mediators of virtual team learning, which affect the performance of virtual team learning for entrepreneurship competence in both *personality traits* and *position*. Compared with virtual taskwork and ICT, teamwork is the most vital factor in virtual team learning for entrepreneurship competence. To improve the effectiveness of virtual team learning, scholars, educators, and policy-makers need to focus on these three factors, especially teamwork.

Meanwhile, academic researchers argued that the backgrounds of learners influence the performance of EE. This study statistically proved both educational degree and family entrepreneurial backgrounds affect virtual teamwork and ICT. Additionally, females and males are different in ICT. Plus, gender and entrepreneurial family history affect taskwork in this study. Therefore, instructional designers should consider gender, educational degree, and family entrepreneurial background when implementing an entrepreneurial course by the adoption of virtual team learning.

This current study shows several main limitations that need to be solved and discussed later. The variances are discussed in general which contains teamwork, taskwork, and ICT, as well as five demographic moderators. When collecting data, responses' answers are extreme, namely, all items are "totally agree" or "totally disagree". One entrepreneurial teacher told researchers: "I totally agree on each item. I really want to use educational technology." But others' reasons cannot be collected by this questionnaire survey. The forthcoming study aims to provide qualitative data to uncover the underlying factors in greater detail. In addition, all items are perceived from an individual aspect. Further research might analyze the perception from individuals,

teammates, and tutors (Zhao et al., 2021). Although this questionnaire survey method can collect data from a broad-spectrum, it might disturb validity of this study. To be more concise, However, the impact factors are complicated and many factors need to be controlled. An experimental setting might be adopted in further research to avoid internal and external validity threats. Since the responses from various HEIs located in the developed area (Yangtze River Delta region) of China, they cannot be represented as the general situation in the whole of China. The next research might conduct interviews and questionnaire surveys to collect data from other Chinese areas.

References

Agudo-Peregrina, Á. F., Iglesias-Pradas, S., Conde-González, M. Á., & Hernández-García, Á. (2014). Can we predict success from log data in VLEs? Classification of interactions for learning analytics and their relation with performance in VLE-supported F2F and online learning. Computers in Human Behavior, 31, 542–550. https://doi.org/10.1016/j.chb.2013.05.031

Akhmetshin, E. M., Romanov, P. Y., Zakieva, R. R., Zhminko, A. E., Aleshko, R. A., & Makarov, A. L. (2019). Modern approaches to innovative project management in entrepreneurship education: A review of methods and applications in education. Journal of Entrepreneurship Education, 22, 1–15.

Andersén, J., & Ljungkvist, T. (2021). Resource orchestration for team-based innovation: A case study of the interplay between teams, customers, and top management. R&D Management, 51(1), 147–160. https://doi.org/10.1111/radm.12442

Arias, E., Barba-Sánchez, V., Carrión, C., & Casado, R. (2018). Enhancing Entrepreneurship Education in a Master's Degree in Computer Engineering: A Project-Based Learning Approach. Administrative Sciences, 8(4), 58. https://doi.org/10.3390/admsci8040058

Balan, P., & Metcalfe, M. (2012). Identifying teaching methods that engage entrepreneurship students. Education + Training, 54(5), 368–384. https://doi.org/10.1108/00400911211244678

Bandera, C., Eminet, A., Passerini, K., & Pon, K. (2018). Using Mind Maps to Distinguish Cultural Norms between French and United States Entrepreneurship Students: JOURNAL OF SMALL BUSINESS MANAGEMENT. Journal of Small Business Management, 56, 177–196. https://doi.org/10.1111/jsbm.12398

Barnowska, B., & Kozaryn, M. (2018). Benefits from the implementation of project tasks with the use of virtual team. Management, 22(2), 204–216. https://doi.org/10.2478/manment-2018-0032

Baron, R. A. (2006). Opportunity Recognition as Pattern Recognition: How Entrepreneurs "Connect the Dots" to Identify New Business Opportunities. Academy of Management Perspectives, 20(1), 104–119. https://doi.org/10.5465/amp.2006.19873412

Baruch, Y., & Lin, C.-P. (2012). All for one, one for all: Coopetition and virtual team performance. Technological Forecasting and Social Change, 79(6), 1155–1168. https://doi.org/10.1016/j.techfore.2012.01.008

Baum, J. R., Locke, E. A., & Smith, K. G. (2001). A multidimensional model of venture growth. Academy of Management Journal, 44(2), 292–303.

Beddoes, K., & Panther, G. (2018). Gender and teamwork: An analysis of professors' perspectives and practices. European Journal of Engineering Education, 43(3), 330–343.

Bell, R., & Bell, H. (2020). Applying educational theory to develop a framework to support the delivery of experiential entrepreneurship education. Journal of Small Business and Enterprise Development, 27(6), 987–1004. https://doi.org/10.1108/JSBED-01-2020-0012

Blenker, P., Trolle Elmholdt, S., Hedeboe Frederiksen, S., Korsgaard, S., & Wagner, K. (2014). Methods in entrepreneurship education research: A review and integrative framework. Education + Training, 56(8/9), 697–715. https://doi.org/10.1108/ET-06-2014-0066

Burt, R. S., & Burzynska, K. (2017). Chinese Entrepreneurs, Social Networks, and Guanxi. Management and Organization Review, 13(2), 221–260. https://doi.org/10.1017/mor.2017.6

Cannon-Bowers, J. A., & Salas, E. (2001). Reflections on shared cognition. Journal of Organizational Behavior, 22(2), 195–202. https://doi.org/10.1002/job.82

Carlson, J. R., Carlson, D. S., Hunter, E. M., Vaughn, R. L., & George, J. F. (2013). Virtual Team Effectiveness: Investigating the Moderating Role of Experience with Computer-Mediated Communication on the Impact of Team Cohesion and Openness. Journal of Organizational and End User Computing, 25(2), 1–18. https://doi.org/10.4018/joeuc.2013040101

Chumg, H.-F., & Huang, C.-J. (2021). Investigating the Relationships Between Cultural Embeddedness, Happiness, and Knowledge Management Practices in an Inter-Organizational Virtual Team. Frontiers in Psychology, 11, 512288. https://doi.org/10.3389/fpsyg.2020.512288

Clark, D. N., & Gibb, J. L. (2006). Virtual team learning: An introductory study team exercise. Journal of Management Education, 30(6), 765–787.

Crawford, E. R., & LePine, J. A. (2013). A Configural Theory of Team Processes: Accounting for the Structure of Taskwork and Teamwork. Academy of Management Review, 38(1), 32–48. https://doi.org/10.5465/amr.2011.0206

Czyzewska, M., & Mroczek, T. (2020). Data Mining in Entrepreneurial Competencies Diagnosis. Education Sciences, 10(8), 196. https://doi.org/10.3390/educsci10080196

Davidsson, P., & Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. Journal of Business Venturing, 18(3), 301–331. https://doi.org/10.1016/S0883-9026(02)00097-6

De Dreu, C. K. W., & Weingart, L. R. (2003). Task versus relationship conflict, team performance, and team member satisfaction: A meta-analysis. Journal of Applied Psychology, 88(4), 741–749. https://doi.org/10.1037/0021-9010.88.4.741

Decuyper, S., Dochy, F., & Van den Bossche, P. (2010). Grasping the dynamic complexity of team learning: An integrative model for effective team learning in organisations. Educational Research Review, 5(2), 111–133.

Demirkan, H., & Spohrer, J. (2015). T-Shaped Innovators: Identifying the Right Talent to Support Service Innovation. Research-Technology Management, 58(5), 12–15. https://doi.org/10.5437/08956308X5805007

Duval-Couetil, N., & Shartrand, A. (2016). The Role of Entrepreneurship Program Models and -Experiential Activities on Engineering Student Outcomes. 27.

Elyousfi, F., Anand, A., & Dalmasso, A. (2021). Impact of e-leadership and team dynamics on virtual team performance in a public organization. International Journal of Public Sector Management, 34(5), 508–528. https://doi.org/10.1108/IJPSM-08-2020-0218

Entin, E. E., & Serfaty, D. (1999). Adaptive Team Coordination. Human Factors: The Journal of the Human Factors and Ergonomics Society, 41(2), 312–325. https://doi.org/10.1518/001872099779591196

Fejes, A., Nylund, M., & Wallin, J. (2019). How do teachers interpret and transform entrepreneurship education? Journal of Curriculum Studies, 51(4), 554–566.

García-Morales, V. J., Martín-Rojas, R., & Garde-Sánchez, R. (2020). How to Encourage Social Entrepreneurship Action? Using Web 2.0 Technologies in Higher Education Institutions. Journal of Business Ethics, 161(2), 329–350. https://doi.org/10.1007/s10551-019-04216-6

Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. The Internet and Higher Education, 19, 18–26. https://doi.org/10.1016/j.iheduc.2013.06.002

Goldstein, A., & Gafni, R. (2019). Learning Entrepreneurship through Virtual Multicultural Teamwork. Issues in Informing Science and Information Technology, 16, 277–305. https://doi.org/10.28945/4332

Guest, D., & King, Z. (2004). Power, innovation and problem-solving: The personnel managers' three steps to heaven? Journal of Management Studies, 41(3), 401–423.

Halberstadt, J., Timm, J.-M., Kraus, S., & Gundolf, K. (2019). Skills and knowledge management in higher education: How service learning can contribute to social entrepreneurial competence development. Journal of Knowledge Management.

Handler, W. C. (1990). Succession in Family Firms: A Mutual Role Adjustment between Entrepreneur and Next-generation Family Members. Entrepreneurship Theory and Practice, 15(1), 37–52. https://doi.org/10.1177/104225879001500105

Harms, R. (2015). Self-regulated learning, team learning and project performance in entrepreneurship education: Learning in a lean startup environment. Technological Forecasting and Social Change, 100, 21–28. https://doi.org/10.1016/j.techfore.2015.02.007

Hart, C. M., Berger, D., Jacob, B., Loeb, S., & Hill, M. (2019). Online learning, offline outcomes: Online course taking and high school student performance. Aera Open, 5(1), 2332858419832852.

Holtkamp, P., Lau, I., & Pawlowski, J. M. (2015). How software development competences change in global settings-an explorative study: HOW SOFTWARE DEVELOPMENT COMPETENCES CHANGE IN GLOBAL SETTINGS. Journal of Software: Evolution and Process, 27(1), 50–72. https://doi.org/10.1002/smr.1701

Hytti, U., Stenholm, P., Heinonen, J., & Seikkula-Leino, J. (2010). Perceived learning outcomes in entrepreneurship education: The impact of student motivation and team behaviour. Education + Training, 52(8/9), 587–606. https://doi.org/10.1108/00400911011088935

Igwe, P. A., Okolie, U. C., & Nwokoro, C. V. (2021). Towards a responsible entrepreneurship education and the future of the workforce. The International Journal of Management Education, 19(1), 100300. https://doi.org/10.1016/j.ijme.2019.05.001

Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in Organizations: From Input-Process-Output Models to IMOI Models. Annual Review of Psychology, 56(1), 517–543. https://doi.org/10.1146/annurev.psych.56.091103.070250

Ismailov, M., & Laurier, J. (2021). We are in "the breakout room." Now what? An e-portfolio study of virtual team processes involving undergraduate online learners. E-Learning and Digital Media, 204275302110397. https://doi.org/10.1177/20427530211039710

Jeong, H., & Hmelo-Silver, C. E. (2016). Seven Affordances of Computer-Supported Collaborative Learning: How to Support Collaborative Learning? How Can Technologies Help? Educational Psychologist, 51(2), 247–265. https://doi.org/10.1080/00461520.2016.1158654

Kariv, D., Cisneros, L., & Ibanescu, M. (2019). The role of entrepreneurial education and support in business growth intentions: The case of Canadian entrepreneurs. Journal of Small Business & Entrepreneurship, 31(5), 433–460. https://doi.org/10.1080/08276331.2018.1468974

Laitinen, K., & Valo, M. (2018). Meanings of communication technology in virtual team meetings: Framing technology-related interaction. 32.

Lans, T., Blok, V., & Wesselink, R. (2014). Learning apart and together: Towards an integrated competence framework for sustainable entrepreneurship in higher education. Journal of Cleaner Production, 62, 37–47. https://doi.org/10.1016/j.jclepro.2013.03.036

Lepine, J. A., Colquitt, J. A., & Erez, A. (2000). ADAPTABILITY TO CHANGING TASK CONTEXTS: EFFECTS OF GENERAL COGNITIVE ABILITY, CONSCIENTIOUSNESS, AND OPENNESS TO EXPERIENCE. Personnel Psychology, 53(3), 563–593. https://doi.org/10.1111/j.1744-6570.2000.tb00214.x

Liguori, E., & Winkler, C. (2020). From Offline to Online: Challenges and Opportunities for Entrepreneurship Education Following the COVID-19 Pandemic. Entrepreneurship Education and Pedagogy, 3(4), 346–351. https://doi.org/10.1177/2515127420916738

Lilleväli, U., & Täks, M. (2017). Competence models as a tool for conceptualizing the systematic process of entrepreneurship competence development. Education Research International, 2017.

Luo, Y., Huang, Y., & Wang, S. L. (2012). "Guanxi" and Organizational Performance: A Meta-Analysis. Management and Organization Review, 8(1), 139–172. https://doi.org/10.1111/j.1740-8784.2011.00273.x

Man, T. W., Lau, T., & Chan, K. F. (2002). The competitiveness of small and medium enterprises: A conceptualization with focus on entrepreneurial competencies. Journal of Business Venturing, 17(2), 123–142.

Man, T. W. Y. (2007). Understanding Entrepreneurial Learning. 8(3), 10.

Marques, L. A., & Albuquerque, C. (2020). Entrepreneurship education going remote- A response to Covid-19 restrictions. 23(2), 9.

Mathews, C. H., & Moser, S. B. (1995). Family background and gender: Implications for interest in small firm ownership. Entrepreneurship & Regional Development, 7(4), 365–378. https://doi.org/10.1080/08985629500000023

Mayordomo, R. M., & Onrubia, J. (2015). Work coordination and collaborative knowledge construction in a small group collaborative virtual task. The Internet and Higher Education, 25, 96–104.

McConnell, D. (2018). E-learning in Chinese higher education: The view from inside. Higher Education, 75(6), 1031–1045. https://doi.org/10.1007/s10734-017-0183-4

Mitchelmore, S., & Rowley, J. (2010). Entrepreneurial competencies: A literature review and development agenda. International Journal of Entrepreneurial Behavior & Research.

Mitchelmore, S., & Rowley, J. (2013). Entrepreneurial competencies of women entrepreneurs pursuing business growth. Journal of Small Business and Enterprise Development, 20(1), 125–142. https://doi.org/10.1108/14626001311298448

Molleman, E. (2005). Diversity in demographic characteristics, abilities and personality traits: Do faultlines affect team functioning? Group Decision and Negotiation, 14(3), 173–193.

Morris, M. H., Webb, J. W., Fu, J., & Singhal, S. (2013). A Competency-Based Perspective on Entrepreneurship Education: Conceptual and Empirical Insights. Journal of Small Business Management, 51(3), 352–369. https://doi.org/10.1111/jsbm.12023

Müller, R., & Antoni, C. H. (2020). Individual perceptions of shared mental models of information and communication technology (ICT) and virtual team coordination and performance—The moderating role of flexibility in ICT use. Group Dynamics: Theory, Research, and Practice, 24(3), 186–200. https://doi.org/10.1037/gdn0000130

Nabi, G., Walmsley, A., Liñán, F., Akhtar, I., & Neame, C. (2018). Does entrepreneurship education in the first year of higher education develop entrepreneurial intentions? The role of learning and inspiration. Studies in Higher Education, 43(3), 452–467. https://doi.org/10.1080/03075079.2016.1177716

Newman, S. A., & Ford, R. C. (2021). Five Steps to Leading Your Team in the Virtual COVID-19 Workplace. Organizational Dynamics, 50(1), 100802.

Ngoc Khuong, M., & Huu An, N. (2016). The Factors Affecting Entrepreneurial Intention of the Students of Vietnam National University—A Mediation Analysis of Perception toward Entrepreneurship. Journal of Economics, Business and Management, 4(2), 104–111. https://doi.org/10.7763/JOEBM.2016.V4.375

Niemiec, R. M. (2019). Finding the golden mean: The overuse, underuse, and optimal use of character strengths. Counselling Psychology Quarterly, 32(3–4), 453–471. https://doi.org/10.1080/09515070.2019.1617674

Nissen, H. A., Evald, M. R., & Clarke, A. H. (2014). Knowledge sharing in heterogeneous teams through collaboration and cooperation: Exemplified through Public–

Private-Innovation partnerships. Industrial Marketing Management, 43(3), 473–482. https://doi.org/10.1016/j.indmarman.2013.12.015

Nowiński, W., Haddoud, M. Y., Lančarič, D., Egerová, D., & Czeglédi, C. (2019). The impact of entrepreneurship education, entrepreneurial self-efficacy and gender on entrepreneurial intentions of university students in the Visegrad countries. Studies in Higher Education, 44(2), 361–379. https://doi.org/10.1080/03075079.2017.1365359

Olson, J. S. (2017). Helping first-year students get grit: The impact of intentional assignments on the development of grit, tenacity, and perseverance. Journal of The First-Year Experience & Students in Transition, 29(1), 99–118.

Olson-Buchanan, J. B., Sahatjian, Z., & Sterling, C. M. (2020). Walk the talk: Incorporating virtual team research in the classroom. Industrial and Organizational Psychology, 13(4), 474–478. https://doi.org/10.1017/iop.2020.81

Oosterbeek, H., van Praag, M., & IJsselstein, A. (2008). The impact of entrepreneurship education on entrepreneurship competencies and intentions: An evaluation of the Junior Achievement Student Mini-Company Program.

Paray, Z. A., & Kumar, S. (2020). Does entrepreneurship education influence entrepreneurial intention among students in HEI's? Journal of International Education in Business, 13(1), 55–72. https://doi.org/10.1108/JIEB-02-2019-0009

Parrish, C. W., Guffey, S. K., & Williams, D. S. (2021). The impact of team-based learning on students' perceptions of classroom community. Active Learning in Higher Education, 14697874211035078.

Pei, L., & Wu, H. (2019). Does online learning work better than offline learning in undergraduate medical education? A systematic review and meta-analysis. Medical Education Online, 24(1), 1666538.

Pittaway, L., & Cope, J. (2007). Entrepreneurship Education: A Systematic Review of the Evidence. International Small Business Journal: Researching Entrepreneurship, 25(5), 479–510. https://doi.org/10.1177/0266242607080656

Pittaway, L., & Edwards, C. (2012). Assessment: Examining practice in entrepreneurship education. Education + Training, 54(8/9), 778–800. https://doi.org/10.1108/00400911211274882

Price, A. M., Devis, K., LeMoine, G., Crouch, S., South, N., & Hossain, R. (2018). First year nursing students use of social media within education: Results of a survey. Nurse Education Today, 61, 70–76. https://doi.org/10.1016/j.nedt.2017.10.013

Ratten, V. (2020). Coronavirus (Covid-19) and the entrepreneurship education community. Journal of Enterprising Communities: People and Places in the Global Economy, 14(5), 753–764. https://doi.org/10.1108/JEC-06-2020-0121

Rogers, P., & Lea, M. (2005). Social presence in distributed group environments: The role of social identity. Behaviour & Information Technology, 24(2), 151–158. https://doi.org/10.1080/01449290410001723472

Rosero, A., Dinh, F., de Visser, E. J., Shaw, T., & Phillips, E. (2021). Two Many Cooks: Understanding Dynamic Human-Agent Team Communication and Perception Using Overcooked 2. ArXiv:2110.03071 [Cs]. http://arxiv.org/abs/2110.03071

Salas, E., Grossman, R., Hughes, A. M., & Coultas, C. W. (2015). Measuring Team Cohesion: Observations from the Science. Human Factors: The Journal of the

Human Factors and Ergonomics Society, 57(3), 365–374. https://doi.org/10.1177/0018720815578267

Samad, S., Nilashi, M., & Ibrahim, O. (2019). The impact of social networking sites on students' social wellbeing and academic performance. Education and Information Technologies, 24(3), 2081–2094. https://doi.org/10.1007/s10639-019-09867-6

Sánchez, J. C. (2013). The Impact of an Entrepreneurship Education Program on Entrepreneurial Competencies and Intention. Journal of Small Business Management, 51(3), 447–465. https://doi.org/10.1111/jsbm.12025

Santateresa, P. I. (2016). Fostering Entrepreneurship in Higher Education, by Problem-Based Learning. In M. Peris-Ortiz, J. A. Gómez, F. Vélez-Torres, & C. Rueda-Armengot (Eds.), Education Tools for Entrepreneurship (pp. 167–182). Springer International Publishing. https://doi.org/10.1007/978-3-319-24657-4_13

Santos, S. C., Morris, M. H., Caetano, A., Costa, S. F., & Neumeyer, X. (2019). Team entrepreneurial competence: Multilevel effects on individual cognitive strategies. International Journal of Entrepreneurial Behavior & Research.

Scott, J. M., Pavlovich, K., Thompson, J. L., & Penaluna, A. (2019). Constructive (mis)alignment in team-based experiential entrepreneurship education. Education + Training, 62(2), 184–198. https://doi.org/10.1108/ET-06-2019-0113

Sirelkhatim, F., & Gangi, Y. (2015). Entrepreneurship education: A systematic literature review of curricula contents and teaching methods. Cogent Business & Management, 2(1), 1052034.

Song, H., Restivo, M., van de Rijt, A., Scarlatos, L., Tonjes, D., & Orlov, A. (2015). The hidden gender effect in online collaboration: An experimental study of team performance under anonymity. Computers in Human Behavior, 50, 274–282.

Taylor, D. W., & Thorpe, R. (2004). Entrepreneurial learning: A process of co-participation. Journal of Small Business and Enterprise Development, 11(2), 203–211. https://doi.org/10.1108/14626000410537146

Turnbull, D., Chugh, R., & Luck, J. (2021). Issues in learning management systems implementation: A comparison of research perspectives between Australia and China. Education and Information Technologies, 26(4), 3789–3810. https://doi.org/10.1007/s10639-021-10431-4

Valliere, D. (2013). Towards a schematic theory of entrepreneurial alertness. Journal of Business Venturing, 28(3), 430–442. https://doi.org/10.1016/j.jbusvent.2011.08.004

van Ginkel, S., Gulikers, J., Biemans, H., Noroozi, O., Roozen, M., Bos, T., van Tilborg, R., van Halteren, M., & Mulder, M. (2019). Fostering oral presentation competence through a virtual reality-based task for delivering feedback. Computers & Education, 134, 78–97.

Venkatesh, V., & Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science, 46(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Shaw, J. D., Sykes, T. A., Wamba, S. F., & Macharia, M. (2017). Networks, Technology, and Entrepreneurship: A Field Quasi-experiment among Women in Rural India. Academy of Management Journal, 60(5), 1709–1740. https://doi.org/10.5465/amj.2015.0849

Wadhwa, V., & Aggarwal, R. (2009). Anatomy of an entrepreneur: Family background and motivation.pdf. 24.

Wang, R., Lowe, R., Newton, S., & Kocaturk, T. (2020). Task complexity and learning styles in situated virtual learning environments for construction higher education. Automation in Construction, 113, 103148. https://doi.org/10.1016/j.autcon.2020.103148

Warhuus, J. P., Tanggaard, L., Robinson, S., & Ernø, S. M. (2017). From I to We: Collaboration in entrepreneurship education and learning? Education + Training, 59(3), 234–249. https://doi.org/10.1108/ET-08-2015-0077

Warkentin, M., & Beranek, P. M. (1999). Training to improve virtual team communication. Information Systems Journal, 9(4), 271–289. https://doi.org/10.1046/j.1365-2575.1999.00065.x

Wen, M., Yang, D., & Rosé, C. P. (2015). Virtual Teams in Massive Open Online Courses. In C. Conati, N. Heffernan, A. Mitrovic, & M. F. Verdejo (Eds.), Artificial Intelligence in Education (pp. 820–824). Springer International Publishing.

Xie, K., Hensley, L. C., Law, V., & Sun, Z. (2019). Self-regulation as a function of perceived leadership and cohesion in small group online collaborative learning. British Journal of Educational Technology, 50(1), 456–468.

Yin, H., Lu, G., & Wang, W. (2014). Unmasking the teaching quality of higher education: Students' course experience and approaches to learning in China. Assessment & Evaluation in Higher Education, 39(8), 949–970. https://doi.org/10.1080/02602938.2014.880107

Zhao, Y., Srite, M., Kim, S., & Lee, J. (2021). Effect of team cohesion on flow: An empirical study of team-based gamification for enterprise resource planning systems in online classes. Decision Sciences Journal of Innovative Education, 19(3), 173–184.

6 Investigating digital entrepreneurship competence in an online practical program

6.1 Introduction

EE course is one compulsory module for all enrolled learners in Chinese HEIs, both colleges and universities, with two credits, aiming to cultivate future enterpriser and entrepreneurship identity, entrepreneurship mindset, as well as entrepreneurship professorships (Heinonen & Poikkijoki, 2006; Fayolle & Gailly, 2008), leading to self-employment after graduation being a trend, as well as the booming of entrepreneurial matches or competitions. EE, different from science, technology, engineering, and mathematics (STEM) fields, cultivates learners' social competence in launching a new venture and being innovative employees, such as communication, collaboration, and initiation. The challenge of online EE is that distributed learners lack physical space to communicate during course breaks and cannot find hints and information through body language (Chen et al., 2021). Thus, "learning by doing" or starting a real business, an essential characteristic of the EE (Donnellon et al., 2014; Forster-Holt, 2021; Gibb, 1996; Liguori & Winkler, 2020), is difficult to conduct by distributed learners and instructors, especially lacking social relations between entrepreneurs and their co-founders' communication. However, the online practical entrepreneurship training program (O-PETP) is not limited to location and time, especially regarding the shortage of experienced EE teachers and other educational resources in the HEIs (Powell, 2013). The O-PETP outlines core steps to support authentic learning where pitching real projects and writing self-reflections enhance learners' entrepreneurship performance in the near future (Kassean et al., 2015; Miles et al., 2017).

Digital transformation and the drastic development of digital technologies bring new entrepreneurial opportunities to start-ups, stand-ups, and scale-ups of almost every economic sector (Hu\djek et al., 2019; Kraus et al., 2018), especially that Information technology eliminates the risk of a shortage of resources for small businesses (Boyles, 2011). Would-be entrepreneurs with higher education backgrounds have privileges (Davidsson & Honig, 2003; Kourilsky & Walstad, 2002). Starting a digital business is appropriate for undergraduates with fewer social resources and networking than those with experience. Learners who master digital entrepreneurship competence easily

launch a digital venture successfully. Scholars combine digital competence and entrepreneurship competence as two separate equal sections or digital competence as a subordinate element (e.g., Hu\djek et al., 2019; Kurmanov et al., 2020; Ngoasong, 2017) whereas the digital entrepreneurship competence framework (EmDigital) with detailed indicators is more scientific and goes further than the other research (Prendes-Espinosa et al., 2021). The framework is a well-structured model containing broad and theoretical elements highly relevant to successful digital entrepreneurs, which is scarce in Chinese, English, and other languages world.

The application of this model in practice, however, needs to be further demonstrated, and founders' digital entrepreneurship competence is little mentioned in the digital entrepreneurship field (Gimmon & Levie, 2010; Kraus et al., 2018). Therefore, the current study adopts this framework to evaluate the effectiveness of this O-PETP in practice. In the following sections, Section 2 interprets practical EE and digital entrepreneurship competence, and research questions. The description of the methodology is in Section 3. Section 4 displayed findings and results. The discussion is in Section 5. The last section concluded with a conclusion, the shortcomings of this study, and possible further study.

6.2 Theoretical framework

6.2.1 Online practical entrepreneurship training program

At the tertiary education level, innovative and entrepreneurship schools or centers provide lectures, activities, and accelerators to start and run a business in a budding period with investors' support and mentors' guidance. Colleges and universities face many challenges, such as experienced entrepreneurship as educators, which is disproportionate in the entrepreneurship instructors, a high-quality curriculum system, individualized instruction, and an entrepreneurship education ecosystem (Belitski & Heron, 2017; Cui, 2021; Krueger, 2007; Weiming et al., 2016). Based on the dearth of entrepreneurship resources, educators and administrators invite mentors with entrepreneurship experience and resources outside of schools. Given the broadly distributed Chinese participants from HEIs and the Zero-COVID public health policy by the Chinese government, online entrepreneurship training programs can organize distributed learners with varied demographic and academic backgrounds. Learners complete a project with distance members, helpful to learn from each other and

extending social networking for the potential enterprise.

The online practical program was started by our team organizer in the spring of 2022 and the current short lecture is an updated P-OETP that focuses on digital entrepreneurship competence. The current entrepreneurship training program focuses on education “through entrepreneurship”, namely learners’ starting a new business (Gibb, 1996). The program will be analyzed from three key elements of pedagogy, namely learning, teaching, and curriculum since online setting is special for both learning and teaching, not only learning (Garrison et al., 2003; Sirelkhatim & Gangi, 2015).

Educators have some freedom to provide educational technology tools for effective online entrepreneurship education to enable learners’ distance learning, such as social media, serious games, and AI (Knox, 2022; Liguori & Winkler, 2020; anonymous). Quantitative research proved that social media group benefits online team task completion, as well as team coherence (anonymous). In this study, distributed teammates communicate and exchange information about their ongoing projects on WeChat. An entrepreneurship learning platform is constructed with structured guidance and detailed steps (one is on three times convergent and divergent entrepreneurial ideas to match problem/solution match. The other examinates market/customers match from marketing, finance, law and etc.) for entrepreneurial learners and educators, adopting Google’s three hours design sprints that simplified Stanford Design School’s version. 54,265 Chinese users registered on this system until Oct. 2022. We used two main functions of this learning management system: Tinder Festival and Accelerator Camp to conduct the entrepreneurial certain steps with fixed tools and visualize team efforts. Tinder festival matures enterprising ideas by two times convergent and divergent thinking. Accelerator Camp makes ideas into new products or services further. Lark is a platform for submitting homework and attending lectures. It is also a team collaboration platform to share course resources and communicate with participants. The three applications provide connections among learners and detailed learning flows to self-regulation learning and online team learning during the eight-week initiative program.

84 participants registered for this one-hour online lecture and 67 completed eight times lectures and seven times homework. One mentor and ten tutors (five teachers and five

students) supported online learning. The course consists of two main parts: entrepreneurship competence and digital competence. The two sections were combined and displayed in Tinder Festival, opportunity identification, the introduction of entrepreneurship, team building, the introduction of digital entrepreneurship, product designation, product operation, and the final pitch. The first seven lectures are closed and the last session is open to anyone interested.

Entrepreneurship education methods, case studies, guest speakers, lectures, serious games, and entrepreneurship simulations, are appropriate to various entrepreneurial content and objectives, such as entrepreneurial knowledge, skills, and mindsets (Byrne et al., 2014; Fayolle, 2018; Hägg & Gabrielsson, 2019). To improve entrepreneurial behaviors and subjective impact measures (i.e., intention and motivation), involving a practical entrepreneurship training program enables students to learn from experience, reflect on their behaviors, and update their skills for the next round of venture creation (Rasmussen & Sørheim, 2006; Colombelli et al., 2022). Entrepreneurship education simulates entrepreneurship process, leading to learners learning from behavior or doing, bridging theory and practice and is useful to cultivate entrepreneurship performance as well as entrepreneurship intention (Forster-Holt, 2021; Kassean et al., 2015). Digital technology (digital artifacts, platforms, and infrastructure), as an enabler and/or outcome, reshapes entrepreneurship in such as the venture creation process, digital business model, and ecosystem (Nambisan, 2017; Sahut et al., 2021). Technology literacy and professional background are prerequisites for digital entrepreneurs. Except for digital technology and entrepreneurship theory, digital entrepreneurship education emphasizes integrating digital technology with entrepreneurial theory deeply such as digital marketing and digital product, which is an apparent difference section from traditional entrepreneurship learning and teaching.

The experiential learning method is mainly conducted in face-to-face settings. Although an online experiential program attempts to remedy the shortcomings of experienced teacher resources, an online learning environment short of interaction happens in local communities, for example, would-be entrepreneurs and capital investors meet in the University café in Silicon Valley. Thus, entrepreneurship pedagogy needs to be further considered in learning, curriculum, and teaching. Additionally, there are few experimental studies that summarize feedback from both teachers and learners. To

facilitate online education in the field of social science, our first research question is displayed below:

Q1: How is the feedback on the online practical entrepreneurship training project?

6.2.2 Digital entrepreneurship competence

This current research focuses on the performance of digital entrepreneurship competence. Research hardly balances digital competence and entrepreneurship competence in the model of digital entrepreneurship competence (e.g., Kurmanov et al., 2020; Ngoasong, 2017). Prendes-Espinosa and her colleagues (2021) constructed a digital entrepreneurship competence framework, EmDigital. The EmDigital framework can be employed for the descriptive assessment of HEIs students (Prendes-Espinosa et al., 2021). Our second question analyzed learners' digital entrepreneurship competence after the O-PETP by using this digital entrepreneurship competence model.

The dimension, the identification of opportunities, is the first stage for venture creation. Although digital entrepreneurship competence is essential for entrepreneurs, lucrative opportunities (Gartner, 1988) underpin the success of venture creation. Opportunity identification needs to be close to customers and sensitive to the market for digging into real customer needs and pain points (Morrison et al., 2003). Learners need to search for appropriate knowledge, skills, and methods in solving ill-structured and open-ended real questions (Krueger, 2007). Discovering opportunities in certain places timely, enhancing value prospects, and anticipating changes are requirements of opportunity identification. With the moderating of knowledge and cognition, would-be entrepreneurs target customers and use tools (i.e., value proposition canvas) to evaluate opportunities (Wood & Williams, 2014). Schumpeter regards entrepreneurs are innovators who break the equilibrium of the economic status quo and discover new opportunities (disruptive innovation). The relationship between entrepreneurship and innovation: entrepreneurship is a sub-process of innovation, transferring new knowledge into a business (Hindle, 2009). However, Kirzner (1983) emphasizes less innovation and more on undetected imperfection. For entrepreneurs with higher education backgrounds, innovative entrepreneurial opportunities are more attractive. This research emphasizes the innovation of ideas and opportunities.

Q2-1: How is learners' digital opportunity identification competence after O-PETP?

Action preparation is a synonym for *action planning* is the last stage before

entrepreneurs' initiation. *Success orientation* entails *prospecting* in *professional consulting*, *business planning*, and *cost evaluation*. *Professional consulting*, especially entrepreneurship experts as educators is essential for learners to be real entrepreneurs (Krueger, 2007). The cost of a digital startup is lower and easier to evaluate, compared to a traditional industry (Felin et al., 2019). We instead business model of business planning. For one side, effectuation as our EE theoretical framework focuses on what we have and then uses existing resource to design products or services. Business planning is based on a causal process that emphasizes what products we want to launch and mobilize resources later (Sarasvathy, 2009). On the other side, the designers did not entail business planning in the indicators, which leads to users roughly considering business planning as a business model. Therefore, three indicators relevant to business planning are almost the same as a business model in the EmDigital framework. *Leadership* is a vital element in the digital entrepreneurship (Basly & Hammouda, 2020). The nature of leadership is about constructing relationships with others such as co-founders, employees, and customers (Walsh & Martin, 2022). Individual identity in entrepreneurship is considered as taking on an entrepreneurial role, influencing behaviors and thoughts (Crosina, 2018). Digitalization has a crucial role in entrepreneurial identity and formulation of the identification (Mmbaga et al., 2020). The creation and management of digital entrepreneurship identity is a new task for digital entrepreneurs. Management competence is taken as essential by venture capitalists when they invest in start-ups (Storey & Greene, 2010). An old saying: "You can have a good idea and poor management and lose every time. You can have a poor idea and good management and win every time" (Kaplan et al., 2009, cited by Gladstone and Gladstone, pp.91-2). The founders and angel employees need to assume social responsibility, although the organization is in the startup stage. Here are two sub-questions:

Q2-2: How is learners' action planning competence after O-PETP?

Q2-3: How is learners' management competence after O-PETP?

Initiation is when participants start to launch a product or service *and collaboration* goes through the whole entrepreneurship process. The initiation means not an initial stage (similar to action planning), but an initial development defined by Gruber (2002) where the processes of starting a business have been set up. The would-be

entrepreneurs launch digital channels to broadcast digital services and products. The digital entrepreneurship identity starts to be created among agents and its generated data needs to be managed. Venture creation and digitalization are deeply intertwined in the initial executive stage. Communication happens in both online and offline contexts among co-founders with the assistance of ICT. Co-founders' entrepreneurial collaboration, especially remoted ones require specialized tools to standardize the procedures of venture creation for beginners (e.g., Tinder Festival). The digital minimal viable product (MVP) is launched, might be overturned by releasing a brand-new product. The entrepreneurs directly communicate with customers, get first-hand feedback, and gain practical experience, leading to irritating the detail of the business model, product, or service. Here is the last question:

Q2-4: How is learners' initiation and collaboration competence after O-PETP?

Although we separated digital entrepreneurship competence into four segments, they are intertwined in fact. Here the O-PETP attempts to simulate real entrepreneurial process and its standardizing. This is a simulation or even a real venture creation, not the typical gamification of launching a business since students' projects might gain angel capital and continue to conduct their business models after this online program. Educators and learners can manipulate and conduct steps by themselves on our entrepreneurship learning management system. Thus, practical activities provide a chance to utilize and master *opportunity identification*, *action planning*, *initiation and collaboration*, and *management & safety*. Online entrepreneurship training programs can release the dearth of experienced teachers and the restriction policy. Therefore, practical entrepreneurship training programs might facilitate learners' digital entrepreneurship competence, increasing entrepreneurship intention and connecting theory and practice (Mmbaga et al., 2020).

6.3 Methods

The study was conducted to collect feedback on an O-PETP and assess learners' digital entrepreneurship competence from September 20 to November 5, 2022 (eight weeks). There are three consultants for the research method. One consultant is a German online educational expert for the instruction design of the O-PETP, one is a business administration educator for the questionnaire and interview outlines and the third one who owns a business is a practical entrepreneurship expert at two Chinese top

universities for selecting learning content. Two main methods, namely questionnaire survey and semi-structured interview complemented each other to collect quantitative and qualitative data, additional data supplied by such as individual reflections, team works, and forums.

6.3.1 Questionnaire

Questionnaire design

The teacher questionnaire with 17 indicators and the student one with extended competencies with 52 questions were designed by authors on the basis of the EmDigital framework. In the teacher questionnaire, the explanation of two sub-competencies, *leadership* and *motivation & perseverance*, is composed of two separate elements, divided into four competencies. In the learner questionnaire, because of the same cause, seven of 45 indicators set by inventors of the EmDigital framework were exploded into 14. We have a table below with interviewees' demographic information (i.e., major and grade). The questionnaire is non-anonymous and collects their gender and name, corresponding with their individual homework and team tasks.

Participants

The program participants were recruited from nine Chinese HEIs. They are undergraduates and major in different fields, i.e., business, computer science, biology, and music. *N* = 84 students passed the initial interview organized by the tutors of each group. There are five groups. Students in four groups study at the same universities or colleges where their tutor work and the four tutors guided them online and offline. Whilst learners come from different institutes in one group and completed their tasks online (Group 1).

Data collection and analysis

The study collected quantitative (assessment questionnaires from teachers and students) to answer the pointed two main questions. The mentor and researcher introduced and encouraged all students to fill in the self-reported questionnaire during the last online lecture. *N* = 48 students completed it non-anonymously in two weeks. Five tutors were invited to assess students' achievement by using a shortened assessment questionnaire and four completed and sent it back. After four tutors quantitatively and qualitatively analyzed eight projects through a modified EmDigital framework that was graded from 1 (really bad) to 5 (really good), as well as students'

individual reflections, one researcher discussed with each tutor and agreed on the assessment to achieve high reliability and validity. We used Jupyter Notebook with Python 3.0 (freely available) to analyze questionnaire data and Matplotlib to visualize the results.

6.3.2 Interview

Interview design

Because respondents easily remember their successful experiences, an interview can go further to know the reasons and get responses in depth (Storey & Greene, 2010). The interview questions with twelve questions (six questions about digital entrepreneurship competence, five about the program, and one background question about their entrepreneurial experience and detailed interpretation) were designed to collect qualitative data. We analyze the feedback of O-PETP on curriculum, teaching, and learning. The other part of the interview outline collected students' feedback on four sub-digital entrepreneurship competencies and their individual reasons.

Interview conduction

To avoid only successful learners responding to our interview requirements, we sent messages to all who positively replied to us during the questionnaire survey invitation. Meanwhile, we interviewed students who completed their individual homework and tutors who guided students' practical projects. Interviews were recorded with the interviewees' agreement. *N* = 15 students and *N* = 4 tutors were interviewed voluntarily. The duration of the interview is 40.45 mins and 48.71 mins separately. The basic interviewees' information was shown in Table 6-1.

Table 6-1 The Demographic Information of Student Interviewees

Interviewee	Group	Grade	Gender	Major	Role	Number of Experience Year	Online
G1-8	G1	4	Female	Accounting	CEO	2	Y
G1-9	G1	2	Male	Business mgt	CEO	1	Y
G1-15	G1	3	Female	Accounting	No	2	Y
G1-20	G1	1	Female	Food science	No	0	Y
G1-24	G1	1	Male	Computer science	No	0	Y
G1-26	G1	2	Male	Music	No	1	Y
G2-5	G2	2	Female	E-marketing	No*	0	B
G2-11	G2	2	Male	Marketing	CEO	1	B
G2-17	G2	1	Female	Marketing	No	0	B

G2-18	G2	1	Female	E-marketing	No	0	B
G3-7	G3	4	Male	Finance	CEO	2	B
G3-8	G3	4	Female	Industry design	No	2	B
G4-6	G4	4	Male	Music	CEO	2	B
G4-17	G4	4	Female	Finance	No	0	B
G5-9	G5	3	Female	Environment design	No	1	B
T1	G1	N/A	Female	Management	Tutor	0	Y
T2	G2	N/A	Male	Computer science	Tutor	2	B
T3	G3	N/A	Male	Construction	Tutor	0	B
T5	G5	N/A	Male	Art design	Tutor	14	B

*G2-5 was a real manager in her team, B=blended.

Data analysis

Recorded audio was transferred into text coded using NVivo. Deductive codes were derived from the theoretical foundation and framework presented above. For the analysis of research questions, we used word frequency and thematic analysis based on the deductive codes as well as newly generated inductive codes.

Other data

The learning management system recorded the results of the first three times of team project procedures. And the left four times of team tasks were uploaded on Lark, as well as learning content. Additionally, learners read four recommended books and wrote reflections with more than 300 Chinese words on Lark where the mentor set a Question and Answer (Q&A) forum. The individual reflection is a structured document containing four sections: objective, reflective, interpretive, and decisional (ORID), reflected seven times in lectures. Three researchers (one mentor and two tutors) assess and check students' individual and team homework.

6.4 Results

6.4.1 Findings of the online practical entrepreneurship training program (RQ 1)

This eight-week project is updated based on the second version by decreasing the content of Web3, because of its difficulty for novices, increasing entrepreneurship theories, and keeping the team's practical tasks, the details discussed thereafter. The main points of feedback on O-PETP from both tutors and learners were drawn in Figure 6-1.

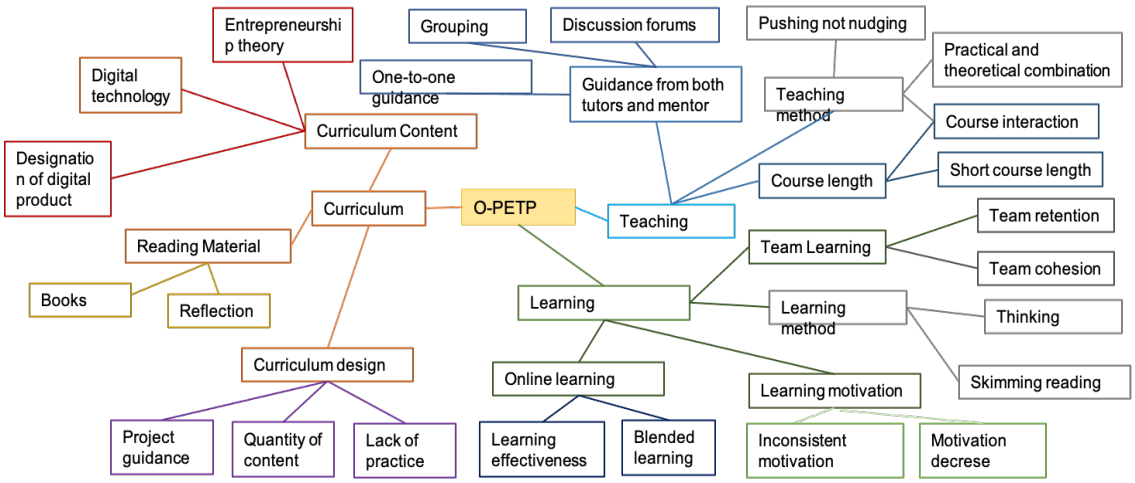

Figure 6-1 Concept map of main points of O-PETP

Curriculum

The results of the curriculum are interpreted from curriculum content, extra learning material, curriculum design, and practice thereafter.

Curriculum content, such as entrepreneurial theory (effectuation, design thinking, and lean startup), entrepreneurial opportunity identification, digital product design and operation, and entrepreneurial team were distributed each week. Students need to design digital products, complete team e-books, and evaluate their teammates, as well as their individual lecture reflections. Interviewees' favorite section of the curriculum is digital content (*N* = 6), entrepreneurship theory (*N* = 6), and the utilization of technology tools (*N* = 3) separately. Broaden of the horizon was mentioned by two students and two tutors and one student mentioned the well-organized curriculum is useful to train his thinking logic. Digital content introduced the basic concepts of a decentralized autonomous organization (DAO), non-fungible token (NFT), and the operation of digital products or services. The mentor introduced tools to design a digital prototype for learners without programming and designing skills. In the last four weeks, students from other majors spent much time learning programming (*N* = 77) and designation (*N* = 71), aiming to design a digital product (e.g., digital game, NFT, or mobile application). The mentor encouraged students to master programming as a basic skill. However, the learning content is not professional in both programming and designing and students also need to spend vanish quantity of time on the given tools (e.g., Bubble) (T2 and T5). The second group tutor (T2) pointed out that learning applications cannot replace learning computer science infrastructures and core skills. And basic programming

language is not a threshold for our students, for example, Python is developer-friendly. While the fifth group tutor (T5) took opposite opinions on digital content. He thought not all learners need to master programming language and computer science deeply while knowing basic knowledge and skills is essential. Meanwhile, he thought recommended designing software applications that are only useful for laymen but they are not easy to learn. One student also mentioned that tools cannot work and their function was limited (G3-8).

To help self-learning after each lecture, the course designer provided extra links and materials for further reading. Students mentioned the extra reading materials with 300 Chinese characters reflection each work was too stressful and they cannot finish them timely for both three years of college and university students, which leads to a lack of deep thinking. Slightly more than half of the interviewees (*N* = 10) had negative comments on reading reflection homework. Mainly because they cannot complete this task in high quality and they still had a learning burden of their major learning. One tutor (T1) said: *"If the order is too hard to be completed, do not issue it"* (T1, personal communication, November 21, 2022). Furthermore, T4 mentioned that reading book reflection was superficial and theoretical, leading to a shortage of time for practice. T1 also said: *"Mr. Yin taught students studying in a high-ranking university. The course is a part of their major' requirement and that class is a small group with 16 students. So high strength course requirement is not a problem (and) high-level requirement is not a problem. But the environment of this course has changed. It is not a course attending to acquire credits. This course assembled with a workshop and practical task. The previous students had no time problems. This practical program needs software and hardware support."* Additionally, three students mentioned the links were unavailable because of Chinese internet policy. Two interviewees thought English learning material was difficult to read and understand.

Students and tutors agreed with the curriculum design in general. However, the second group had a discussion together after the last lecture and the attendee gave feedback: the teaching content of each lecture should be specific and the broad learning content can be given additional learning materials and links for self-regulation learning. The tutor of Group 5 (T5) also mentioned the amount of course content was too massive and the course is not their major course, being extra pressure for learners and

decreasing learning motivation.

Two tutors mentioned that the course had too much theoretical interpretation and less chance to train learners' practical competence. One tutor who attended the second time of online program told us that the mentor moved practical content and guidance to tutors who should guide learners after class (T1). The practical section is controversial since the learning performance is lower than expected, although the course designers emphasize 'learn by doing' and the project team was formed and conducted at the first lecture. But this program was still more practical than the entrepreneurship curricula open by their universities (*N* = 2). Three experienced learners dropped off after the first course since they felt the course was too theoretical, as mentioned by their tutor. Two interviewees hope that the course can facilitate learners to design a product within a potential market. One student interviewee who ran a tea shop one year ago pointed out that the practice cannot take action well and students cannot take their own responsibility (G4-6). But he would recommend this course because the course contains key points of how to start a business.

Learning

Through categorizing the interview materials, online learning, learning motivation, learning methods, and team learning are shown in detail.

Interviewees (*N* = 2) mentioned clearly that online learning and collaboration are not enough and lack team cohesion. Online teaching negatively affects learning since the course has less learning pressure and supportive activities to push them (G1-15). One interviewee said blended learning is the best way (all participants meet at least one time in person) and organizing more online activities for each team to increase social presence (G1-8). Learning in an online environment makes learners cannot keep focus on their tasks well. They are easily distracted and struggle with making brainstorming activities (*N* = 3).

Almost half of the interviewees (*N* = 7) hold a learning motivation that is inconsistent with the course objective of inspiring venture creation. Attending this project is part of their graduation project in Group 3 or gains an extra course score in Group 4. These attendees took this program as a compulsory course without higher expectations (i.e., start a venture). One interviewee mentioned they set a common learning objective in the beginning, which facilitates the course with high quantitative and qualitative results

(G2-18). While the other interviewee said their team had not achieved a clear common goal at the beginning (G1-15). T5 mentioned entrepreneurship learning motivation was high before joining this program. However, learning motivation decreased drastically after the first one or second lecture. One reason is course designers did not give clearer guidance for practical tasks. To complete their entrepreneurial projects, attendees need high and consistent learning motivation (G3-7). And the course designers should provide sufficient scaffolds. If possible, the teachers encourage and push learners and their teams to report their projects two or three times during the lecture (T1). By this method, they can complete tasks on time with high quality, which in turn increases their learning motivation and active learning. Interviewees (N = 15) told us their motivation slightly improved and one mentioned team collaboration facilitates her learning motivation (G2-18). Additionally, students (N = 11) applied for joining the following project to continue improving digital entrepreneurship competence. Six students acquired new learning methods, team learning (N = 1), skimming reading (N = 2), reflection (N = 2), and ways to improve efficiency (N = 1) separately. Thinking is deeper and more logical than before (N =3).

Based on the recorded team homework in Lark, we continue to analyze their learning from team aspects. 18 students (21.43%) cannot complete their individual reflection on each lecture more than three times (N_{G1}=5, N_{G2} = 9, N_{G4} = 3, N_{G5} = 1). The second and the fifth group have higher retention than other groups with 100% and 92.31% separately. Except for the first group, other team tutors organized their students to meet in person at least one time. For example, the third group of students consulted their tutor four times, and the tutor provided five times chances to visit local business organizations in person. Additionally, the entrepreneurship training project is highly connected with their dissertations, namely, the course is a section of the senior-year students' graduation work. Without any face-to-face connection and communication, the first group's retention rate is 80.77%. Between the last but not least lecture and the last one, students were encouraged to make an appointment to present their projects and report their questions at that time in Group 1. One student mentioned: *"We discussed making an appointment with the tutors. But until the last minute, the other teammates didn't say anything in our WeChat group. I was really angry and felt pity. But the 'CEO' didn't encourage us. I kept silent and lost the chance" (G1-24, personal*

communication, November 16, 2022). Two of the six teams chased this communication opportunity positively. Lacking team cohesion or learning motivation, the other teams failed to report their team project and were not recommended to present a pitch at the last lecture.

Teaching

We distributed teaching themes into guidance from both mentor and tutor, teaching method, course length, and other ten themes. The details are shown in Table 6-2.

Table 6-2 Subtheme of teaching from Interview data

Subtheme	Number of Interviewee	References
Guidance from both mentor and tutors	16	37
Practice teaching	14	25
Course length	6	6
Teaching method	6	7
Interaction with mentor	5	5
F2F is better	2	2
Separate learning tasks	2	3
Teaching experience	2	3
Professional teacher	1	1
Tasks too heavy	1	1
Preview learning content	1	1
Internet has problem	1	1
Individualized teaching	1	1
Class belonging	1	1

Learners approved lecturer gave a lecture each week and tutors guided their projects. Regarding theoretical tasks, the tutors need to score and comment on students' individual and team homework, which made students correct their misunderstandings of learning content (*N* = 3) and felt the tutor paying attention to them (*N* = 2). However, students need more guidance and scaffolding to complete practical tasks with high quality (*N* = 5). The online interaction between the mentor and learners is not enough either (*N* = 5). Although the mentor pointed out the shortcomings of all projects one time, learners prefer timely feedback each week. Because the tutors and learners of Group 1 were not familiar with each other, T1 mentioned: *"We have difficulty guiding them (distributed students) and cannot push them too much. All teams should present*

their projects three or four times and teachers should attend their presentation". Without after-class explanations by tutors, learners cannot absorb learning content sufficiently (*N* = 3).

Two groups (Group 2 and 4) organized activities to know each other. T2 arranged an opening ceremony and even grouped the learners based on their interests before the training program. The mentor asked all students to post entrepreneurial ideas and the attendees chose one they liked. Then the students were regrouped by ideas and interests. Regarding our Q&A forum, two interviewees liked it and two tutors thought the forum was not used enough. Our online forum stored 22 answered questions asked by ten students (12.20%) and one tutor (16.67%). The highest attendance frequency is one student who asked six questions and one tutor who wrote down four times. One student mentioned she cannot follow new questions on the forum (G2-18). T2 pointed out a course belonging (belongingness of the course) is important for students.

Interviewees (*N* = 5) found the lecture length need to be extended. Because the teaching knowledge is too much and the interaction is not enough (*N* = 4). Three interviewees suggested extending it to one and a half hours whereas one interviewee cannot have any longer time for the lecture. Two students want to exchange their ideas with the mentor and get feedback directly during the lecture, which can understand the learning content well to facilitate learning and taking action. The learners from different universities can communicate and get fresh ideas and depth of understanding (*N* = 2). Course designers need more support from enrolled HEIs and the local communities (T2). For this reason, learners from two groups learned together in a classroom and they discussed learning contents together, remedying the shortage of interaction in the one-hour lecture, disrupted by COVID-19.

Two tutors argue the mentor had no teaching experience to teach and tutor students from non-highly-ranked universities. These students with lower learning motivation and enthusiasm need a nudge or even a strong push to complete their team tasks. Encouraging learners is essential when they want to give up and students need pressure from the teacher's side. In the beginning, the mentor mentioned kicking out the failed students, but this rule didn't execute (G4-6). The students want to get pressure and encouragement from the mentor. Because good or bad performance has no significant influence on their further learning (G1-15).

The combination of theory and practice learning methods is attractive to all participants. Five interviewees pointed out that lacking practice standards or clear practical learning aim to guide and complete practical tasks, which leads to learners being confused about how to make a digital product and a wide gap in the quality of outputs. Two tutors with entrepreneurship experience suggested a practice guidebook for learners to follow. Or the mentor gave clearer explanation during the lecture. One tutor disagreed with it because of the uncertainty and innovation of entrepreneurship and agreed to a clearer practice learning objective (T1). With regard to the practice guidance part, one tutor who has 14 years of entrepreneurial experience and runs a design venture now, criticized the curriculum designers heavily. He mentioned: *"We lack practical products at the end of the course. The tutor doesn't have teaching experience in practice learning. The individual reflection with four parts is helpful. However, the project guidance has no clear assessment indicators"* (T5, personal communication, November 14, 2022).

One practice learning objective is to make an MVP and present it at the last lecture. However, they started this task in the middle of this course and many students had no learning motivation to design a digital product. The mentor should let students know this learning objective in the beginning and completing individual reflection and theoretical homework is not enough (T5). And this makes no MVP was designed and executed (N = 3). Two tutors said we should give students more time to identify opportunities before they started their team tasks because this part is complicated and a good idea will be easily taken into action instantly.

The mentor posted the learning content in advance for learners' preview. T5 suggested inviting professional mentors to teach computer science and designation to help students master skills faster. Two interviewees pointed out each student learns different content (programming, designation, and management) in light of their interests and background.

6.4.2 Digital entrepreneurship competence (RQ 2)

The quantitative data come from student self-reporting as shown in Figure 6-2 (on the left side, the top left is *opportunity identification*, the top right is *action planning*, the bottom left is *initiation and collaboration*, and the bottom right is *management*) and teacher assessment (the tutor of the fourth group did not participant) in Figure 6-3, supplied by 19 interview data.

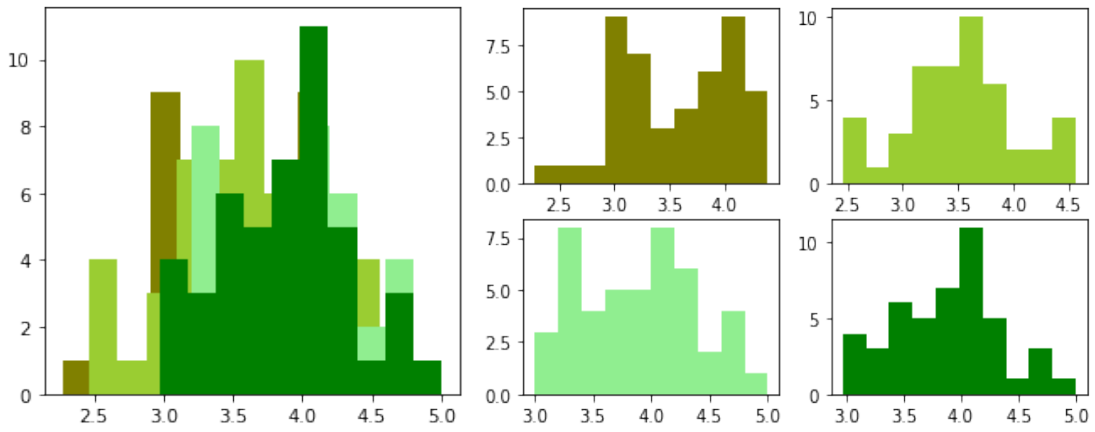

Figure 6-2 The distribution of four competencies from learners' self-reporting

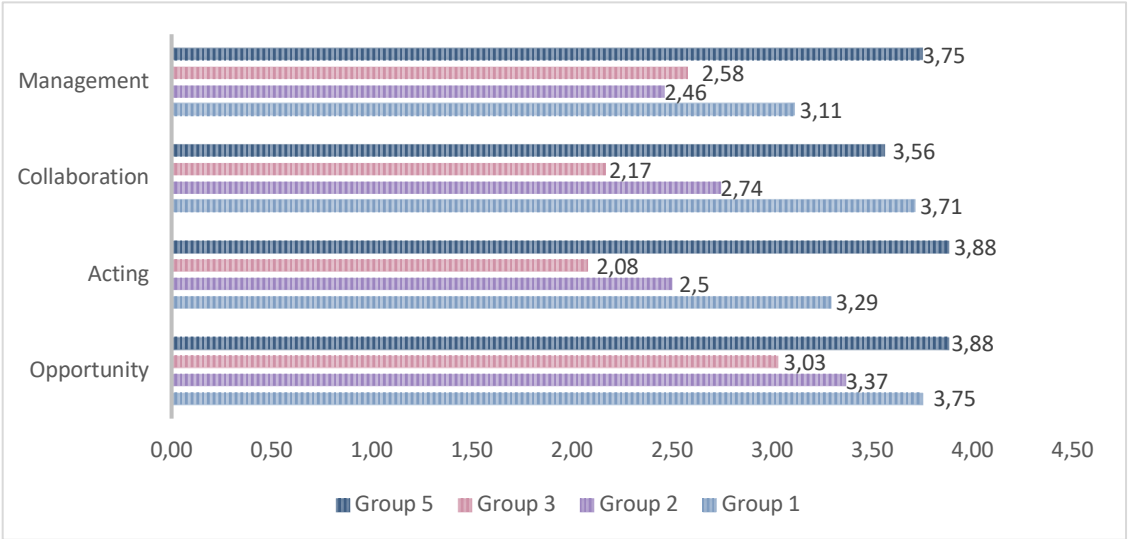

Figure 6-3 The distribution of four competencies from tutors' assessment

Digital opportunity identification

The distribution of digital opportunity identification has two peaks around 3 and 4 in Figure 2. This sub-competence is the highest score marked by tutors' assessment (M_t = 3.50, SD = 0.38). Students' self-reporting (M_s = 3.54, SD = 0.52) is higher than that of tutors. However, among all four competencies, this is the third-highest score for student self-assessment. Male learners reported their opportunity identification competence higher than those of females. As seen in Figure 3, T5 commented higher than other tutors and T3 gave the lowest score. The digital course content is a fresh area for learners. As Group 1 for example, when we interviewed 29 candidates for Group 1 before the course, only one student was familiar with Web3 and we did not hire him since the project is for novices. Therefore, part of the learning content is totally new for participants. The interview results showed students understand digital content

better than before. Meanwhile, students systematically master the knowledge of entrepreneurship theory. Nine interviewees mentioned digital entrepreneurship opportunity identification is urgent to learn and master. Interviewees thought they lack capability in innovation and creation (*N* = 3), digital knowledge (*N* = 3), and opportunity identification (*N* = 2) whereas this competence is complicated (*N* = 2). All four tutors argue this O-PETP inspires students' interests to know the overview of venture creation and gain digital entrepreneurship competence, especially Web3. T2 pointed out engaged students tried to assess their ideas by analyzing the real industry. He said: "*I can score 4 on opportunity identification. Because they knew how to search for innovative ideas and start to explore some content, and how to implement them. In fact, the students were able to grasp some of the keys to many problems, such as how to deploy some of the problems that might be latent. For example, in Dai's team project, Urgent Needs Exchange, they actually had a preliminary idea, and they understood, for example, what a community-based e-commerce or a community-based Urgent Needs Exchange as this would look like*" (T2, personal communication, November 24, 2022).

However, the project cannot be an incubator that facilitates learners to start a business. Their team projects were postponed here and the learners would not take further action to create a venture. Three students planned to take this project to attend entrepreneurial competitions which is not our main teaching objective. And the methods of opportunity assessment were theoretically taught but their usage has problems. The Group 3 tutor (T3) thought the lecture lacks detailed guidance to specify the entrepreneurial process. T3 said: *"It is the relevant knowledge area (Web3), in fact, the specific knowledge, through this one-time class told them to master, for them is still quite difficult. Because they have never been exposed to it before. But I think from this level of knowledge, he (the student) knows that there is such a thing. If you really want to do it, you have to spend a lot of time after the class to implement it to know how to do it. It opens a door for them and they still don't know exactly how to do it"* (T3, personal communication, November 11, 2022).

One student (G3-7) organized a non-profit project and had been running it for one year. He planned to transfer their service online, inspired by this online program. He pointed out that he was not sensitive enough to identify entrepreneurship opportunities. Except for individual competence deficiency, digital opportunity identification is a tough

activity, especially in the fickle Web3 field. Therefore, seven students and two tutors mentioned this digital opportunity identification competence is the most necessary to enhance.

Students' entrepreneurial ideas were written down on self-designed learning management system and other students joined the project because of their interests at the first lecture. They developed ideas through business model canvas, marketing survey questionnaire, and other tools provided on the system. The detailed steps were set to follow by student teams instead of the mentor's guidance. Opportunity identification theory was explained in the fourth lecture and the mentor gave the last chance to change their project themes. The first tutor said: *"It's late to change the project ideas. For students with low motivation, they have no intention and they also need to get support from one or two teammates to change it".*

Initiation and collaboration

The scoring of *Initiative and Collaboration* is distributed between 3.00 and 5.00 in Figure 2. As shown in Figure 3, this competence is low from the tutors' side (M_t = 3.04, SD = 0.72) whereas the learners' self-report scored the highest (M_s = 3.89, SD = 0.51). T1 gave the highest score of 3.71 and T3 gave the lowest of 2.74. The sub-competence is analyzed through the interview and team homework data below.

Four interviewees mentioned their initiation did not execute well. The projects came out by learners were identified as lacking coherent implementation plans (G1-20), thereby highlighting the deficiency of entrepreneurial experience (G4-6). T3 pointed out the program is neither a compulsory course nor a real venture creation. This impedes cultivating the above-mentioned competence. Additionally, learners from G3 attended this program as part workload of their thesis and they have low

Team cohesion felt by each learner is subjective. For example, two interviewees had opposite attitudes toward their team collaboration (e.g., G4-6 and G4-17). One team organizer with higher competence thought his teammates were run-riders (G4-6). Two team organizers did not believe in their teammate's competence and they did each main task by themselves. One interviewee mentioned that the team organizer pointed out what each teammate did during their team meeting (G2-18).

Online collaboration can gain different ideas because the learners come from other areas and universities (N = 2). But without meeting in person, learners had problems

collaborating and brainstorming. Three interviewees liked their team and their collaboration went well. They knew each other from this program and they meet in person. One team with a common objective collaborates better than a team without a common objective (*N* = 2). Communication with teammates (*N* = 3) and other students (*N* = 2) are not enough.

One student said she felt tired and angry to handle more tasks than her teammates (G5-9). T2 suggested the team should submit a memo to show team progress and task distribution because two CEOs took over the team tasks and their teammates completed a small amount. Namely, task distribution is difficult for students. When interviewing the CEO (G2-11), he wanted to improve collaboration competence: *"This aspect of cooperation needs to be improved. Another example is this class, I did all this alone, which is one way, but I actually have a heavy burden on me, and I was thinking if there is a possibility to let or share it with them (teammates). They should be assigned to do not only a promotion for myself but also to improve their ability to export to the outside world. I think I'm still not doing too well"* (G2-11, personal communication, November 15, 2022).

Five interviewees from four teams that did not pitch their projects mentioned they and their teammates lack the competencies to complete team tasks. And five interviewees thought the grouping needs to be improved. The most liked projects easily hire co-founders and ask for their background to build a well-structured co-founder' team whereas the other project ideas are less developed. They preferred someone they already had known each other and they came from different majors.

There were five groups applying different types of team cooperation to finish their team task each week. In Group 1, because they (*N* = 26) are distributed in China and they did not know each other before joining this course, they completed their team projects online without meeting in person. Two of the five team projects were completed and one project was pitched in the last lecture. In Group 2, *N* = 20 came from the same business schools and attended the lecture in a classroom the first three times. After the lecture, T2 asked them to discuss the content of the lecture. Two teams were suggested to pitch their project. Then COVID-19 cases appeared in this city and students can only discuss team tasks online. In Group 3, *N* = 8 came from the same college and all of them did this project as part of their thesis in the last year of their Bachelor studies. The tutors

organized four times visiting for them and gave three times individual guidance for the course participants. In Group 4, *N* = 18 was studying in the same college and they can complete their team homework in their specialized classroom. In Group 5, *N* = 16 participants also met in person to complete their projects and COVID-19 made them collaborate remotely. Hence, excluded the first group, the other four groups meet in person with their tutors and teammates at least one time. With regard to the presentation ratio, Group 1 is the lowest (15.34%), Group 3 is the highest (50%) and Group 2 is the second highest (40%). Because the tutor of each group needs to recommend a team to present their project, the presentation ratio of Group 2 is higher than Group 3.

Student interviewees from final presentation teams support team collaboration in both online and blended ways whereas the students' team did not present their project, they prefer face-to-face cooperation and collaboration. The learners from the pitched teams assessed higher on this sub-competence. In conclusion, T3 argued students should improve their collaboration competence, compared to the other three entrepreneurship competencies.

Action planning and management

Action planning was distributed appropriately normally and learners scored management mainly between 3 and 4.5. Both action planning (M = 2.94, SD = 0.80) and management (M = 2.98, SD =0.72) are lower than 3 points from the tutors' assessment. Learners scored action planning as the lowest (M = 3.51, SD = 0.52) and management gained M = 3.88, SD = 0.49. Students assessed themselves higher than the tutors, although they performed not well as teachers expects in these eight weeks. T3 gave the lowest score of 2.08 and T5 gave the highest of 3.88 in action planning. Whilst T5 marked the highest of 3.75 and T2 marked the lowest score of 2.46 in management. 21 projects were prompted in the first lecture and six projects were presented in the last lecture, shown in Figure 6-4.

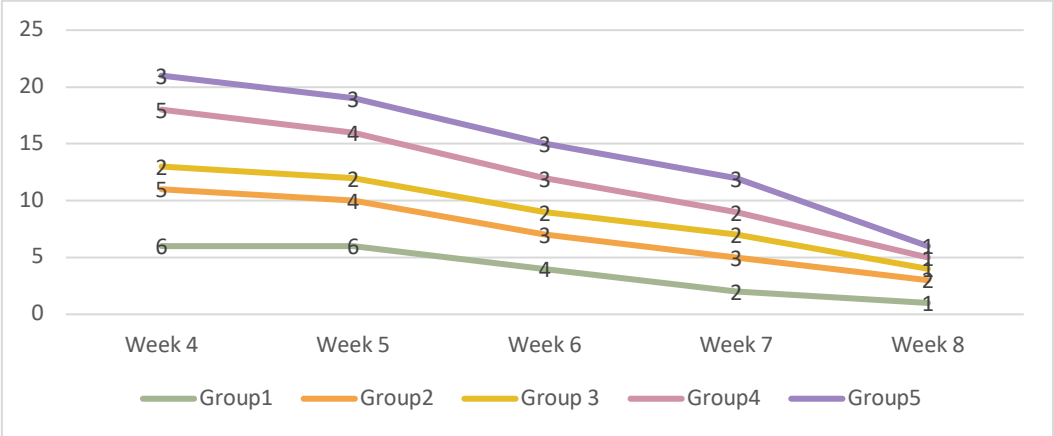

Figure 6-4 Completed team projects during the eight weeks

Through analyzing of Group 2 (N = 20) individual and team homework, two students dropped out after the first lecture. Nine failed students gave the course up at the fourth lecture because they attended the first three lectures hybrid and their tutor asked and answered their questions after the online lecture. Since the fourth time, they attended the lecture totally online because of the COVID-19 outbreak in this Chinese city. The high dropout rate impacts completing team tasks, impeding the acquirement of action planning and management competencies. As seen in Group 1, half of the students completed their individual homework on the last day of submission. Although the mentor assigned tasks weekly, the students need to distribute and plan their tasks. It might be a burden of tasks since students have no time to think and make a comprehensive plan (N = 3). One interviewee mentioned they had a fixed time to discuss how to assign team tasks each week. We can find students with entrepreneurial experience worked well on action planning. These multitasks provided a chance to learn time and multitasks management.

In the first lecture, students gave an idea and they voted for them. The student who proposed ideas and got the top votes in each group became the CEO of that project. Two tutors mentioned the idea creator as a manager is not a good idea. The teams followed the steps in the learning management system and they distributed tasks among teammates in the first three weeks. In the following weeks, because of ill-structured tasks, team organizers and their teammates need to arrange and complete tasks together. The CEO of each team, with passion for their project, can slightly impact "co-founders" and improve the quality of their prototype. Although the "co-founders" choose this project in the beginning, their motivation easily decreased terribly. At the

same time, passionate “CEOs” preferred solving problems by themselves because they were afraid that their teammates cannot complete them well. Except the “co-founders” themselves have high intentions to design and launch their products, if the “CEO” has low motivation, the product would be postponed. We cannot see a project going well when the “CEO” joined less in the project. Only in one team, the “co-founder” can make more efforts, distribute tasks, and lead their project because she had more experience in the field and the “CEO” is a freshman. When interviewed the failed teams, the teammates (N = 2) told us how to manage their projects successfully. However, they lacked the leadership to take over the role of team organizer. The team organizer of each completed team got more practical experience and know better how to improve their management and action planning competence, compared with their teammates. Two teammates also said they improved management competence from their experienced team organizers, learning from imitation.

During the practical tasks to learn action planning and management and safety competencies, interviewees (N = 12) mentioned they did not have enough time on their projects. Four interviewees assigned their team tasks based on teammates’ advantages and they solve problems together. Three interviewees said their planning competence improved and two interviewees agreed that the course is helpful for management competence. Action planning and management executed in online settings are more difficult than in person (N = 5). In the end, T3 mentioned these two competencies cannot increase dramatically in a short time and the course did not provide enough practice opportunities to exercise.

6.5 Discussion

Regarding the founding of two questions: ***Q1: How is the feedback on the online practical entrepreneurship training program? Q2: How is learners’ digital opportunity identification /collaboration /action planning and management competence after the O-PETP?*** We discuss the results thereafter in detail.

6.5.1 Online practical entrepreneurship training Program

This O-PETP encourages attendees to launch a prototype through which improves digital entrepreneurship competence and intentions (Kolvereid & Moen, 1997). The program broadens learners’ horizons, especially in Web3, and sparks students of interest to further learn digital entrepreneurship whereas the development and

deployment of digital prototypes necessitate a skill set that proves to be challenging for would-be entrepreneurs. The following discusses how to conduct online practical entrepreneurship training activities efficiently from curriculum, learning, and teaching. Curriculum and curriculum design are discussed following. The given curriculum consists of the art and science of entrepreneurial theory and digitalization, as well as theoretical and practical homework for both individuals and their teams, which is massive and over-burden for students. The content and designation of the curriculum in online environments should consider learners' needs and learning levels (Fayolle & Gailly, 2008), although their majors and entrepreneurial background are in various (Meyers & Nulty, 2009). Whether to learn digital content and which degrees are controversial topics for digital entrepreneurs. To identify digital entrepreneurship opportunities and start a business, would-be entrepreneurs should be "Jack of all trades", namely generalists who have a balanced skill set (Lazear, 2004; Stuetzer et al., 2013). Nascent entrepreneurs might not spend too much time improving their digital skills, i.e., programming, because they can invite specialists or co-founders to develop core technology or outsource non-core technology to vendors. Additionally, in a short-term training program, course designers should balance practical and theoretical content when adopting learning 'through' entrepreneurship. A more practical and task-orientated post-program, i.e., an internship, should be supplied for learners intending to actualize their entrepreneurial ideas (Kubberød & Pettersen, 2018).

From learning aspects, contemporary entrepreneurship pedagogy theory (i.e., constructivism) is centered on learners and the experiential learning (Hägg & Gabrielsson, 2019). Experiential/practical learning or learning by doing in the online environment impedes its functionality. Well-designed and implemented experiential learning still maintains learners' high involvement such as clear learning objectives, one-to-one meetings, and mentor teams (Cridland et al., 2021). Distributed learners need guidance (more specifically, one-to-one guidance for individual homework and team guidance for entrepreneurial projects) when their projects meet problems and flexibility when prompting their real-world projects (Baasanjav, 2013). Entrepreneurship learning interest and students' efforts declined drastically for learners engaging in shadow. It might be a honeymoon effect (more interested in this program at the outset) (Kauppinen & Choudhary, 2021). Whilst engaged students

increased their entrepreneurship learning motivation or maintain a high level by preparing entrepreneurial projects, in line with Oosterbeek et al. (2010) and Mahendra et al. (2017) mentioning entrepreneurship motivation. Educators encourage involvement in learners' own projects to enhance learning motivation.

Asynchronous and synchronous online communication was provided for distributed learners. However, online collaboration without meeting in person one time impedes their communication, sense of connectedness, and belongingness to complete a project together (Ragusa & Crampton, 2018; Booker, 2007). The usage of the online forum is under expectation. One explanation is that learners are afraid of a negative assessment of their ideas in an unsafe environment (Pocek et al., 2021). In a built safe community, educators provide interaction and information exchange opportunities for learners to share ideas and brainstorm. Online learning with geographically dispersed teammates and mentors is tough work for students. If possible, tutor guidance and project exploitation/exploration are conducted face-to-face whereas the lecture still keeps online as a hybrid learning environment (Bischoff et al., 2018). But with strong support from their tutors, schools, and their teammates, learners can learn from distant cooperation.

Standing in the shoe of teachers, teaching and online teaching are analyzed here. In light of Kolb's experiential learning cycle, there are two gaps: from direct experience to abstract conceptualization and from abstract conceptualization to active experimentation (Kolb et al., 2014). The latter is difficult to jump partly because the mentor did not give clear assessment criteria for assessment and achievement. Practical tasks should give clear requirements at each time point and flexibility since entrepreneurship learning is uncertain and ambiguous (Politis, 2005). The online teaching individual guidance when learners need and team guidance with regularity Teachers can push (nudge or shove) learners to prompt engagement (Hargreaves, 2013). Different from shoving, nudging respects learners' freedom when impacts their decision-making (Brown et al., 2022). Positive nudges such as homework reminders and texting study tips (text messaging) enhance learners' behavioral and cognitive engagement (Costello et al., 2020). Online learning systems where record educational data can be analyzed to what, whom, when, or how to nudge (Brown et al., 2022).

6.5.2 Digital entrepreneurship competence

All of the four sub-competencies were improved: *opportunity identification* and *initiation and collaboration* were higher than *action planning* and *management*, as reported by student interviews.

Digital opportunity identification exhibits the highest level of improvement albeit requiring further enhancements, argued by tutors. This training program as an extra-curricular activity (using students' free time) (de Prada Creo et al., 2021) with fewer limitations from the government provides information on digitalization and its industry trend is attractive for course attendees since they started to notice and know basic knowledge in this field. Moreover, entrepreneurship training programs that extend beyond traditional academic institutions exhibit adaptability and ingenuity in response to industrial evolvement. Regarding Schumpeterian and Kirznerian thought, it is imperative for nascent entrepreneurs to pursue innovative or imperfect information, emanating from comprehensive and extensive learning endeavors. However, as the first time to design digital products, students struggled with opportunity identification and exploitation. Although systematical entrepreneurial knowledge and digital tools broaden their horizon (i.e., remember and understand), based on Bloom's taxonomy, entrepreneurial skills are higher level (i.e., apply, evaluate, and create) to achieve and students need more time and practice to handle (Krathwohl, 2002). That is, digital opportunity identification is a tough competence to examine problem/solution match and the presence of customers, in contrast with traditional entrepreneurship, which changes dramatically and generatively (Nambisan, 2017; Steininger et al., 2022). The digital part is such changeable that nascent entrepreneurs with bounded rationality learn from mistakes and "angel" customers' (profitable customers) feedback (Cope, 2003). Nascent entrepreneurs need to irritate means and ends in the budding period (Shane & Venkataraman, 2000).

Digital entrepreneurship is relevant to the sociology (Davidsson & Honig, 2003). *Initiative & collaboration* heavily depend on their teammates and learning motivation. The students from teams that gave a pitch had better performance on collaboration than those who did not. The team has a maximum of four teammates because team size slightly affects the team's online communication (Luo et al., 2023). When educators guide teams with low self-learning competence, face-to-face supervision is more

efficient and effective than online. Online entrepreneurship education can improve peer collaboration competence through students' connectedness or relatedness (anonymous). However, the effect of online cooperation without well-organized teammates interaction is lower than educators expect in practice-based learning. Regarding team tasks distribution, interview results showed that student CEOs struggled with it partly because being the idea creator does not mean having leadership. Teammates, perceiving not as main team contributors, took less responsibility, reactive to their team projects, and felt like working for the team organizer. All team participants' members belonging and psychological ownership over team projects should be cultivated through team interaction and completing tasks together and team trust affects team collaboration and cooperation, moderated by team virtuality (Breuer et al., 2016; G. Brown et al., 2014). Except for founder teams, nascent entrepreneurs are actors in social networks with bridging and bonding ties and they should implement cooperation and collaboration with other segments to gain human and social capital (Davidsson & Honig, 2003).

Digital entrepreneurship is relevant to management theory and practice. *Action planning* and *management &safety* competence were less improved because these competencies learn through the process of attendees' launching a digital prototype, namely the two competencies should be learned by action and irritation. The reflection homework, however, only focuses on lecture contents, not mentioning practice reflection. Although fixed structured standard, the individual reflection is superficial and rarely mentioned their teamwork, in line with Heinonen and Poikkijoki's (2006) research. Students completed theoretical homework with equal weight to practical homework even the former is higher than the latter in this program. We should give higher weight to practical tasks for the above-mentioned competencies. It is cost-saving and efficient to train leadership through personal learning content supplied by online education programs and digital materials (Moldoveanu & Narayandas, 2019). Self-reflection is a promising strategy to know Master of Business Administration learners themselves and improve leadership in online and face-to-face courses (Rubens et al., 2018). 'Learning by doing' is a valuable method for mastery of the leadership (Corriveau, 2020) and "doing" should be designed by educators. For example, tutors should organize ice-breaking activities to let learners know each other and find someone with

leadership. Furthermore, educators encourage each co-founder to take over their responsibility to build shared leadership that is appropriate to predict new venture performance (Ensley et al., 2003; Hensel & Visser, 2018).

Therefore, entrepreneurship relates to economics, sociology, and management. Digital entrepreneurship competence is complicated, interdisciplinary, and hard to master in the online eight-week program. The mentor lacks teaching experience in practical content, which leads to only improving *digital entrepreneurship opportunity identification* competence explicitly. We will give more attention to practical teaching and support to improve other competencies, as well as clear practical task requirements in our third time online practical program.

6.6 Conclusion

This O-PETP was conducted by an entrepreneurship education company online/hybrid. The online program provided experienced teachers and the latest industry content and entrepreneurship theory for learners whose enrolled universities or colleges lack. In the curriculum section, the digital entrepreneurship content broadens learners' horizons, and the learning interest was stimulated. Although low-code programming and designing applications are neither easy nor professional to learn, the digital entrepreneurship course continues to train a generalist for endeavors of venture creation. Online and face-to-face interactions enhance learners' social presence (interaction and interpersonal relations) which improve learning engagement (Cobb, 2009). Both team and one-to-one guidance are necessary. Additionally, educators should insist on learner-centered didactics and nudge students at risk. Plus, with enough support from tutors, schools, and their teammates, hybrid learning is an alternative option for entrepreneurial learning and teaching.

Regarding digital entrepreneurship competence, all of the four sub-competencies were improved slightly on the basis of interview data. All tutors agreed that opportunity identification is the highest improvement, especially digital content, although the digital tasks need to explain requirements clearly and simply. For learners, *initiative and collaboration* gained the highest score. *Action planning* and *management and safety* heavily depend on their teammates and their own learning motivation, hardly change in short time.

The limitation of this study is that statistical analysis is limited to descriptive analysis since this study collected post-program data without pre-program data. Additionally, we also need long-term research (i.e., an academic year) to examine the digital entrepreneurship competence that cannot change immediately. The European theoretical framework should be further examined in Chinese culture with the Delphi study. Hence, the research team starts to conduct a prior-posttest survey and interview more experienced tutors to analyze the updated next online program (eight weeks on the theoretical part and eight weeks on the practical part) and digital opportunity identification and collaboration.

References

Albrahim, F. A. (2020). Online teaching skills and competencies. Turkish Online Journal of Educational Technology-TOJET, 19(1), 9–20.

Basly, S., & Hammouda, A. (2020). Family businesses and digital entrepreneurship adoption: A conceptual model. The Journal of Entrepreneurship, 29(2), 326–364.

Belitski, M., & Heron, K. (2017). Expanding entrepreneurship education ecosystems. Journal of Management Development.

Bischoff, K., Volkmann, C. K., & Audretsch, D. B. (2018). Stakeholder collaboration in entrepreneurship education: An analysis of the entrepreneurial ecosystems of European higher educational institutions. The Journal of Technology Transfer, 43(1), 20–46.

Booker, K. C. (2007). Perceptions of classroom belongingness among African American college students. College Student Journal, 41(1).

Boyles, T. (2011). Small business and Web 2.0: Hope or hype? The Entrepreneurial Executive, 16, 81.

Breuer, C., Hüffmeier, J., & Hertel, G. (2016). Does trust matter more in virtual teams? A meta-analysis of trust and team effectiveness considering virtuality and documentation as moderators. Journal of Applied Psychology, 101, 1151–1177. https://doi.org/10.1037/apl0000113

Brown, G., Crossley, C., & Robinson, S. L. (2014). Psychological ownership, territorial behavior, and being perceived as a team contributor: The critical role of trust in the work environment. Personnel Psychology, 67(2), 463–485.

Byrne, J., Fayolle, A., & Toutain, O. (2014). Entrepreneurship education: What we know and what we need to know. In Handbook of research on small business and entrepreneurship (pp. 261–288). Edward Elgar Publishing.

Chen, L., Ifenthaler, D., & Yau, J. Y.-K. (2021). Online and blended entrepreneurship education: A systematic review of applied educational technologies. Entrepreneurship Education, 4(2), 191–232.

Cobb, S. C. (2009). Social presence and online learning: A current view from a research perspective. Journal of Interactive Online Learning, 8(3).

Colombelli, A., Panelli, A., & Serraino, F. (2022). A Learning-by-Doing Approach to Entrepreneurship Education: Evidence from a Short Intensive Online International Program. Administrative Sciences, 12(1), 16.

Cope, J. (2003). Entrepreneurial learning and critical reflection: Discontinuous events as triggers for 'higher-level'learning. Management Learning, 34(4), 429–450.

Corriveau, A.-M. (2020). Developing authentic leadership as a starting point to responsible management: A Canadian university case study. The International Journal of Management Education, 18(1), 100364.

Crosina, E. (2018). On becoming an entrepreneur: Unpacking entrepreneurial identity. In A research agenda for women and entrepreneurship (pp. 93–113). Edward Elgar Publishing.
Cui, J. (2021). The impact of entrepreneurship curriculum with teaching models on sustainable development of entrepreneurial mindset among higher education students in China: The moderating role of the entrepreneurial climate at the institution. Sustainability, 13(14), 7950.
Davidsson, P., & Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. Journal of Business Venturing, 18(3), 301–331.
Donnellon, A., Ollila, S., & Middleton, K. W. (2014). Constructing entrepreneurial identity in entrepreneurship education. The International Journal of Management Education, 12(3), 490–499.
Duval-Couetil, N. (2013). Assessing the impact of entrepreneurship education programs: Challenges and approaches. Journal of Small Business Management, 51(3), 394–409.
Fayolle, A. (2018). Personal views on the future of entrepreneurship education. In A research agenda for entrepreneurship education. Edward Elgar Publishing.
Fayolle, A., & Gailly, B. (2008). From craft to science: Teaching models and learning processes in entrepreneurship education. Journal of European Industrial Training.
Felin, T., Gambardella, A., Stern, S., & Zenger, T. (2019). Lean startup and the business model: Experimentation revisited. Forthcoming in Long Range Planning (Open Access).
Forster-Holt, N. (2021). Stimulation versus simulation: The student side hustle as a learning innovation. Entrepreneurship Education and Pedagogy, 4(4), 808–829.
Garrison, D. R., Anderson, T., & Archer, W. (2003). A theory of critical inquiry in online distance education. Handbook of Distance Education, 1(4), 113–127.
Gartner, W. B. (1988). “Who is an entrepreneur?” is the wrong question. American Journal of Small Business, 12(4), 11–32.
Gibb, A. A. (1996). Entrepreneurship and small business management: Can we afford to neglect them in the twenty-first century business school? British Journal of Management, 7(4), 309–321.
Gimmon, E., & Levie, J. (2010). Founder’s human capital, external investment, and the survival of new high-technology ventures. Research Policy, 39(9), 1214–1226.
Gruber, M. (2002). The entrepreneurial mindset: Strategies for continuously creating opportunity in an age of uncertainty. Schmalenbach Business Review: ZFBF, 54(4), 380.
Hägg, G., & Gabrielsson, J. (2019). A systematic literature review of the evolution of pedagogy in entrepreneurial education research. International Journal of Entrepreneurial Behavior & Research.
Heinonen, J., & Poikkijoki, S.-A. (2006). An entrepreneurial-directed approach to entrepreneurship education: Mission impossible? Journal of Management Development.
Hindle, K. (2009). The relationship between innovation and entrepreneurship: Easy definition, hard policy. Paper Delivered to the Refereed Stream of the 6th AGSE International Entrepreneurship Research Exchange, 3–6.
Hu\djek, I., Širec, K., & Tominc, P. (2019). Digital skills in enterprises according to the European digital entrepreneurship sub-indices: Cross-country empirical evidence. Management: Journal of Contemporary Management Issues, 24(2), 107–119.
Kaplan, S. N., Sensoy, B. A., & Strömberg, P. (2009). Should investors bet on the jockey or the horse? Evidence from the evolution of firms from early business plans to public companies. The Journal of Finance, 64(1), 75–115.
Kassean, H., Vanevenhoven, J., Liguori, E., & Winkel, D. E. (2015). Entrepreneurship education: A need for reflection, real-world experience and action. International Journal of Entrepreneurial Behavior & Research.

Kauppinen, A., & Choudhary, A. I. (2021). Gamification in entrepreneurship education: A concrete application of Kahoot! The International Journal of Management Education, 19(3), 100563.
Kirzner, I. M. (1983). Perception, opportunity, and profit. Chicago University Press Chicago, IL, USA.
Knox, S. (2022). Fostering student engagement in virtual entrepreneurship education environments. The International Journal of Management Education, 20(3), 100705.
Kolvereid, L., & Moen, Ø. (1997). Entrepreneurship among business graduates: Does a major in entrepreneurship make a difference? Journal of European Industrial Training, 21(4), 154–160.
Kourilsky, M. L., & Walstad, W. B. (2002). The early environment and schooling experiences of high-technology entrepreneurs: Insights for entrepreneurship education. International Journal of Entrepreneurship Education, 1(1), 1–20.
Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. Theory into Practice, 41(4), 212–218.
Kraus, S., Palmer, C., Kailer, N., Kallinger, F. L., & Spitzer, J. (2018). Digital entrepreneurship: A research agenda on new business models for the twenty-first century. International Journal of Entrepreneurial Behavior & Research.
Krueger Jr, N. F. (2007). What lies beneath? The experiential essence of entrepreneurial thinking. Entrepreneurship Theory and Practice, 31(1), 123–138.
Kurmanov, N., Aliyeva, Z., Kabdullina, G., & Mutaliyeva, L. (2020). Digital entrepreneurship competencies among students: Methodological aspects of the maturity level and development program making. Journal of Entrepreneurship Education, 23(2), 1–11.
Lazear, E. P. (2004). Balanced skills and entrepreneurship. American Economic Review, 94(2), 208–211.
Liguori, E., & Winkler, C. (2020). From offline to online: Challenges and opportunities for entrepreneurship education following the COVID-19 pandemic. In Entrepreneurship Education and Pedagogy (Vol. 3, Issue 4, pp. 346–351). SAGE Publications Sage CA: Los Angeles, CA.
Luo, H., Chen, Y., Chen, T., Koszalka, T. A., & Feng, Q. (2023). Impact of role assignment and group size on asynchronous online discussion: An experimental study. Computers & Education, 192, 104658. https://doi.org/10.1016/j.compedu.2022.104658
Mahendra, A. M., Djatmika, E. T., & Hermawan, A. (2017). The Effect of Entrepreneurship Education on Entrepreneurial Intention Mediated by Motivation and Attitude among Management Students, State University of Malang, Indonesia. International Education Studies, 10(9), 61–69.
Miles, M. P., de Vries, H., Harrison, G., Bliemel, M., De Klerk, S., & Kasouf, C. J. (2017). Accelerators as authentic training experiences for nascent entrepreneurs. Education+ Training.
Mmbaga, N. A., Mathias, B. D., Williams, D. W., & Cardon, M. S. (2020). A review of and future agenda for research on identity in entrepreneurship. Journal of Business Venturing, 35(6), 106049.
Moldoveanu, M., & Narayandas, D. (2019). The future of leadership development. Harvard Business Review, 97(2), 40–48.
Morrison, A., Breen, J., & Ali, S. (2003). Small business growth: Intention, ability, and opportunity. Journal of Small Business Management, 41(4), 417–425.
Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. Entrepreneurship Theory and Practice, 41(6), 1029–1055.
Ngoasong, M. Z. (2017). Digital entrepreneurship in a resource-scarce context: A focus on entrepreneurial digital competencies. Journal of Small Business and Enterprise Development.
Oosterbeek, H., Van Praag, M., & Ijsselstein, A. (2010). The impact of entrepreneurship education on entrepreneurship skills and motivation. European Economic Review, 54(3), 442–454.

Otis, N., Grouzet, F. M., & Pelletier, L. G. (2005). Latent motivational change in an academic setting: A 3-year longitudinal study. Journal of Educational Psychology, 97(2), 170.

Powell, B. C. (2013). Dilemmas in entrepreneurship pedagogy. Journal of Entrepreneurship Education, 16, 99.

Prendes-Espinosa, P., Solano-Fernández, I. M., & García-Tudela, P. A. (2021). EmDigital to promote digital entrepreneurship: The relation with open innovation. Journal of Open Innovation: Technology, Market, and Complexity, 7(1), 63.

Ragusa, A. T., & Crampton, A. (2018). Sense of connection, identity and academic success in distance education: Sociologically exploring online learning environments. Rural Society, 27(2), 125–142.

Rasmussen, E. A., & Sørheim, R. (2006). Action-based entrepreneurship education. Technovation, 26(2), 185–194.

Rubens, A., Schoenfeld, G. A., Schaffer, B. S., & Leah, J. S. (2018). Self-awareness and leadership: Developing an individual strategic professional development plan in an MBA leadership course. The International Journal of Management Education, 16(1), 1–13.

Sahut, J.-M., Iandoli, L., & Teulon, F. (2021). The age of digital entrepreneurship. Small Business Economics, 56(3), 1159–1169.

Sarasvathy, S. D. (2009). Effectuation: Elements of entrepreneurial expertise. Edward Elgar Publishing.

Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. Academy of Management Review, 25(1), 217–226.

Steininger, D. M., Kathryn Brohman, M., & Block, J. H. (2022). Digital Entrepreneurship: What is New if Anything? In Business & Information Systems Engineering (pp. 1–14). Springer.

Stuetzer, M., Obschonka, M., & Schmitt-Rodermund, E. (2013). Balanced skills among nascent entrepreneurs. Small Business Economics, 41(1), 93–114. https://doi.org/10.1007/s11187-012-9423-2

Sun, A., & Chen, X. (2016). Online education and its effective practice: A research review. Journal of Information Technology Education, 15.

Walsh, L., & Martin, B. (2022). The value of leadership practices when there is no one to lead: A nascent entrepreneurship context. Journal of Small Business Management, 1–37.

Weiming, L., Chunyan, L., & Xiaohua, D. (2016). Ten years of entrepreneurship education at chinese universities: Evolution, problems, and system building. Chinese Education & Society, 49(3), 198–216.

Wood, M. S., & Williams, D. W. (2014). Opportunity evaluation as rule-based decision making. Journal of Management Studies, 51(4), 573–602.

7 Discussion and further research

This chapter summarizes the results of entrepreneurship competence in the digital age into five main points shown in Section 7.1. The following section discusses the potential practical implications of this study. Then limitations are argued and the foreseeable future of my next research relevant to this thesis is pointed out in Section 7.3. The final section concludes the research.

7.1 Findings on entrepreneurship competence in the digital age

7.1.1 Findings on entrepreneurship educational technology

The first study (Study 1) analyzed the overview of EE in the digital age by systematically reviewing entrepreneurship educational technologies. Serious games or gamification with game elements are widely adopted in online and blended EE. Unlike entertainment games, serious games emphasize education function, as well as inspire students of interest in learning if they like that game (Yu, 2019). A qualitative study with sixteen students has shown that simulation games of the entrepreneurship process can improve attendees' entrepreneurship mindset (Thanasi-Boçe, 2020), compared to lectures and seminars through passive learning. Serious games stimulate the learning and teaching of venture creation process, facilitating learners' emotional and behavioral engagement, as well as the motivation of being an entrepreneur, not explicitly of the cognitional enhancement (Almeida, 2017; Landers et al., 2018; Thomas & Baral, 2023). Entrepreneurship serious games originate from board games to digital games, developed with technology. Immersive serious games assisted by virtual or augmented reality increase spatial information, increasing digital presence as well as cognitive interest (Ferguson et al., 2020). Entrepreneurial educators and policymakers might get insights from new versions of serious games for their work and policy support. The review findings show that entrepreneurship educators and instructors adopt synchronous and asynchronous social media with different levels of media richness and interaction to receive instant messages, cooperate, and share learning documents among learners, increasing digital social presence and decreasing social isolation (Pimmer et al., 2019). Social media via video occupy young people's time and educators used new tools in education, i.e., Tiktok adopted in the sports education (Escamilla-Fajardo et al., 2021), but video chatting media is not new (e.g., Teng & Taveras, 2004).

The augmentation of bandwidth capabilities has facilitated a broader utilization of video communication media within educational contexts. As a result, video communication media can be more extensively employed as a valuable tool for instructional purposes. Social media mitigates the limitations of online and blended education to increase learner-learner and learner-educator interactions. However, students manipulate two or more media or multitask with social media simultaneously during the lecture, hindering their academic performance, mediated by the attention-controlling (Demirbilek & Talan, 2018; Kokoç, 2021). Findings show that social media combine with other technologies to supply formal and informal EE. Social media for example implement AI to reduce tutors' task burden, varying from replying to repeated questions on the basis of databases to recommend learning materials (Smutny & Schreiberova, 2020).

Before COVID-19, online EE mainly happened in MOOCs platforms, supplied by educational technology tools and applications. The high dropout rate is a challenge for MOOCs, as well as happening in the EE field. The acquisition of entrepreneurial knowledge can be effectively facilitated through digital platforms, whereas the acquisition of entrepreneurial skills through real-world experiences and experimental approaches necessitates additional support. To improve connectedness and closeness, MOOCs educators help learners to know each other by "introduction" section and additional social media (e.g., Coursera, FutureLearn, and Udemy). Now more and more formal entrepreneurship educators put entrepreneurship learning and teaching on digital platforms. For example, the entrepreneurship chair at the University of Mannheim built and run their own closed learning platform (https://www.mcei.de/) to share entrepreneurship information and course materials, as well as organize activities. To attract and retain course attendees, educators adopt learning visualization, as shown in our research (Sun, 2021), and gamification. In entrepreneurship educational technologies research, we need experimental studies to analyze specific learning aspects, such as online assessment (Hayes & Richmond, 2017), and learning methods especially that of being an entrepreneur to facilitate entrepreneurship pedagogy and instruction design. Additionally, mobile learning devices (e.g., smartphones and tablets) facilitate learning everywhere. Developers and educators should take consider mobile versions of educational technologies in the field.

7.1.2 Findings on the status quo of AI used in EE and its foreseeable future

In this second study, the findings reveal that the utilization of big data analytics and machine learning techniques in the field of used in EE enables the analysis of learning data. Although this practice is observed in various disciplines, its significance within the context of EE has not received the same level of attention. Educators should collect multimodal data (i.e., echocardiography) on venture creation learning to make decisions on the basis of data policy. Data analytics predict learning success and provide extra support (i.e., social, academic, and cognitive) for learners' lagging behind (Martin et al., 2020). Data visualization in other educational fields also should be explored in EE to make results readable.

The second study also found machine learning requires a massive amount of data to train and test models, which is less adopted in EE. However, this technology has been used in predicting factors that impact project performance (Graham & Bonner, 2022; Sabahi & Parast, 2020), which is probably to diagnose students' business models. We should add data analytics, machine learning, and other AI technologies in entrepreneurship learning management systems since adaptiveness or personalization is useful to improve collective learning and self-regulation learning, hinted by adaptive or personalized learning management systems. It is observed that the standardization of entrepreneurship learning outcomes poses a considerable challenge. Because design thinking-based EE provides specific steps to manipulate, educators and software developers can use the existing model to design and teach and learners fill in each step. However, the specific guidance during each step is still a heavy burden for tutors. We still need automagical tools to partly take over educators' tasks. That is, intelligent assessment in EE is a further research area. In addition to recommending individualized learning content, we expect machines (computers) to accurately assess learners' entrepreneurship projects and suggest revisions, justified by human intelligence (Schade & Schuhmacher, 2023). Findings show that scholars used AI to predict business model of a project for venture capitalists. Now Chatbot, ChatGPT, released in November 2022, affects education in assessment, curriculum, and other aspects. Based on Zhai's insights (2022), the assessment of entrepreneurship knowledge should less be assessment contents whereas skills (i.e., critical thinking and innovation) assessment should be increased. Natural language processing analyzes audio and textual

documents to assess learners' assignments and project prediction. Therefore, AI and entrepreneurship have two main trends. One is AI supports EE, as my second study reviewed it. Educators and scholars learn how to live with AI machines and enable our business and entrepreneurship pedagogy. AI for prediction of project performance and would-be entrepreneurs. On the other side, AI is combined with entrepreneurship, bringing digital entrepreneurship and changing traditional business mechanisms and scholarship (Robledo et al., 2021).

7.1.3 Findings on virtual team learning in EE

After reviewing educational technologies, the third study quantitively analyzed virtual teams in EE by analysis of virtual teamwork or teamwork/team relation, team taskwork, and ICT. The empirical method interprets that all three ingredients statistically positively affect *entrepreneurial position* and *personality traits* competencies separately. It is noted that we should combine virtual teams with one or more F2F meetings or other activities to increase connectedness and closeness, as a result of Study 4.

The collected samples enrolled in HEIs and they completed tasks remotely because of COVID-19 and Zero-COVID policy. Virtual or online team learning is welcome in both online and F2F EE since it increases collaboration possibilities and saves time. Demographic factors affect the three parts of virtual team learning. Specifically, both educational levels and family entrepreneurship history affect virtual tasks. Gender affects team relations and ICT. That is, female learners perceive higher virtual team cohesion and communication technology than males. While males spend more energy in online settings than females (Yang et al., 2011). It might be females are better to communicate with peers using social media devices. Entrepreneurial family background affects virtual team relations and ICT. Research showed family background positively influences entrepreneurship intention (Matthews & Moser, 1996; Palmer et al., 2021), as well as entrepreneurship personality (Georgescu & Herman, 2020). Therefore, learners' demographic characteristics information is the basis of tutoring their projects (Marques et al., 2018). The three elements (teamwork or team relation, team taskwork, and ICT) interact and impact entrepreneurship competence to different degrees. The multiple linear regression analysis showed teamwork impact *position* and *personality*

strongest. Strong teamwork or team relation stimulates learners' support and encourages each other, beneficial for task planning, progress tracking, and task completion (Crawford & Lepine, 2013). In turn, the completion of team tasks facilitates team satisfaction and team cohesion. Entrepreneurship educators should guide members to enhance team cohesion and social presence. The digital entrepreneurship identity used in online collaboration per se is a skill for would-be entrepreneurs in digital venture creation endeavors. It is noted that self-regulated learning is also effective for entrepreneurship learning, not only team learning (Harms, 2015). One shortcoming of this study is that student self-report questionnaires are relatively subjective and biased. We should provide 360-degree assessments with teachers' and peers' opinions to evaluate their entrepreneurship competence.

7.1.4 Findings on entrepreneurship competence and digital entrepreneurship competence

In light of the built EntreComp framework, Study 2 compares eleven research relevant to entrepreneurship competence with this framework. Opportunity identification, creativity, and management are the three most frequently mentioned sub-competencies of the venture creation process. Opportunity identification is the antecedent of idea exploitation to validate opportunity by building close connections with customers and markets. Actors with creativity and innovation easily produce new products or services (Schmitz et al., 2017). Nascent entrepreneurs should manage resources such as human resources, capital resources, and social capital. Based on the above-mentioned twelve studies, we distributed these competencies into *position* and *personality traits* in Study 3. Except for opportunity identification, entrepreneurs are generalists who need specific competence sets, such as finance, network, and management (Remold, 2012). There is no conscience of the components of personality traits among scholars. Self-efficiency, perseverance, risk or ambiguity tolerance, and creativity are attributes of entrepreneurial personality traits in this study. These four traits are of great significance for both traditional entrepreneurial endeavors and digital ones under the circumstance of uncertainty and risk. The findings of Study 4 showed that opportunity identification is the most necessary for improvement on the basis of interview data. For novices and nascent entrepreneurs, entrepreneurship educators and course designers should provide more chances to practice these skills in the real

world. The competencies of management and collaboration are also important. It might be because the training program already set weekly goals for them, so management competence is least mentioned by both learner and tutor interviewees.

Digital entrepreneurship competence is not simply a combination of digital competence and entrepreneurship competence. The digital entrepreneurship competence framework built by Spain experts integrated entrepreneurship competence and digital competence well. Regarding digital entrepreneurship competence from front-line entrepreneurial educators, digital entrepreneurs need to be “Jack of all trades” or specialists which is still controversial and should be discussed, especially in the mastery of programming skills. Three typical opinions: 1) knowing the basics and low code tools, 2) learning frameworks and data analysis, and 3) no need to learn. Lazear experimented at Stanford University and found entrepreneurs are “Jack of all trades” (Lazear, 2004). The empirical study examined that varied labor market experience and balanced skills positively affect the economics of being an entrepreneur (Bublitz & Noseleit, 2011; Wagner, 2003) whereas varied work experience negatively impacts the income of being paid employment (Åstebro & Thompson, 2011). Nascent entrepreneur's bricolage of resources and different experiences is an important endeavor whilst specialists prefer being an employee and is more suitable (Backes-Gellner & Moog, 2013). Lazear‘s study (2004) findings are limited to nontechnical and high-tech industries and we need to know whether “Jack of all trades” is a Swiss army knife in other industries. Criaco and his colleagues (2014) thought founders’ technological competence is apparently essential, or even a competitive advantage for technology-based institutions (Criaco et al., 2014). Gimmon and Levie (2010) investigated that general technological expertise significantly affects the survival of an enterprise. Unfortunately, this study did not distribute how “general” technology competence is in detail. Based on the fourth study, digital technology mentioned here consists of digital artifacts, platforms, and infrastructure. Founders’ technological or digital competence requirement is less complicated and professional. Further research should point out different levels of digital competence requirements for would-be entrepreneurs.

Scholars and educators are called to conduct research on digital entrepreneurship competence since a scientific and applicable digital entrepreneurship competence scale needs to be further developed for the assessment of potential entrepreneurs.

7.1.5 Findings of an online practical entrepreneurship training program

By adopting of interview method with learners and instructors in the fourth study, the findings reveal that online practical entrepreneurship training program broadened their horizons, which is the most achievement through the eight weeks of learning. The online curriculum consists of digital content and entrepreneurship theory, as well as practical team projects which they learn by doing in their enrolled HEIs. The content is attractive for learners, especially the latest Web3 information.

The determination of educational objectives within the field of EE influences the selection and implementation of pedagogical approaches, instructional materials, and overarching strategies employed in both learning and teaching processes. Since this study aims to cultivate would-be entrepreneurs who plan to start a business directly, we adopt practical EE methods in Study 4, such as learning by doing, learning from the real world, and reflecting on their learning behaviors. Additionally, the ubiquity of online EE is an unmistakable trajectory for business schools, irrespective of their deposition towards embracing this paradigm shift.

The findings of teaching are that we lack interaction between the mentor and learners, appropriate practical teaching methods, and efficient teacher groups. Online teaching and instructors need to be further studied to improve learning performance (Martin et al., 2020). Although we provided a Question and Answer (Q&A) forum, learners cannot follow and attend it timely. This Q&A platform exhibited a notable deficiency in active engagement from learners and the role assumed by the mentor on this platform was that of a manager, rather than a “moderator” tasked with facilitating discussions (Thormann & Fidalgo, 2014). Course attendees were difficult to learn from each other between groups. During each lecture, the mentor turned on video and audio whereas learners mainly send text or audio messages when they answered questions. Our entrepreneurship learning management system should design communication and interaction spaces where learners exchange ideas in certain threads with a high participant rate. The other system (a team working system) should explore more tools, e.g., voting and breakout rooms, to enhance communication. Practical teaching content with vague learning objectives and insufficient guidance from the mentor. The four tutors assisted the mentor in teaching for F2F guidance. One out of five tutors

experienced difficulty in keeping pace with the instructional process, attributable to the impact of COVID-19 as well as the administrative responsibilities within the college. Apart from financial support from universities and colleges, institutional pedagogical and human resource supports are essential for attending online training program.

Our interview data showed that learning motivation decreased drastically without positive and immediate feedback on their learning. Students lacked online learning skills and readiness (Chung et al., 2020), although they had online learning experiences. The finding of the curriculum is that the practical section should be improved with clear requirements. If possible, we develop a guidebook to check the certain phase of launching a product or service and their tasks. In the curriculum design part, there is an explicit shortcoming of the lecture, that is the content being too much for absorbing in a short time. We should arrange and emphasize key points of the learning content and the left is taken as extra material for reading and self-regulation learning. It is noted that based on our course objectives, practical content should be further explained and generally display how to use the given tools. It is necessary to demonstrate practical content and then to learn by imitation and beyond, which inspire active learning and achieve learners' learning needs.

Online lectures and guidance are easily organized online whereas teamwork needs more connected relations to encourage each teammate to talk and give ideas. The online practical programs will facilitate learners to know each other without limitations of time and location. Additionally, the expected prototype is designed on digital devices so educators just provide applications and software, i.e., Figma and Bubble, for learners. Online practical entrepreneurial activities still need time and experiments to update and optimize, with assistance from sufficient support and interaction from educators, schools, and local communities.

7.2 Practical implications

The theoretical implications of those four intertwined studies are discussed well above. This section will go further to explore potential three key practical implications of serial studies in detail. The thesis mainly solves questions about online and blended EE through which educators and their stakeholders understand, assess, and facilitate entrepreneurship competence, as well as digital entrepreneurship competence. There

are five main implications thereafter.

First, through my two reviews of educational technologies and AI for acquiring entrepreneurship competence (Study 1 and Study 2), the studies might inspire entrepreneurial educators and their stakeholders to explore which and how educational technologies support entrepreneurship learning and teaching. Overall, compared to other disciplines, EE and its academic publications seldom mention educational technology. The first study that reviewed educational technology used in EE can attract entrepreneurial educators to pay attention to this area and use technology for improving learning success and engagement. Used social media, serious games, and digital platforms inspire entrepreneurial instructors to adopt them in their daily teaching and guidance and they will have new ideas to concisely fit educational technologies into entrepreneurial pedagogy and instruction design on the basis of learning content (Scuotto & Morellato, 2013). With the rapid development of AI, its potential application in our field can be improved drastically. Except we infuse data analytics, machine learning and adaptive learning management systems into EE fully, our counterparts can use natural language processing tools to answer and evaluate students' homework and projects in both online and face-to-face learning environments, ideas for instruction design from other disciplines.

Second, practical learning in EE is common and scholars proved it is useful for entrepreneurship intention and opportunity identification (Gielnik et al., 2015; Hahn et al., 2017). In the fourth study, the online practical entrepreneurship training program brings experienced entrepreneurial teachers, the latest digital content, as well as professional tutor support to encourage active learning with learners' high-frequency participation. The mentor is an entrepreneur, providing vivid experience in venture creation. Traditional universities (mainly tasks are teaching and academic research) are obtuse and limited in policy, being least engaged in entrepreneurial activities and lacking skills in the online education (Etzkowitz, 2014). However, the online training program organized by a third organization is agile and trains teachers who work in academic institutions. Under lacking entrepreneurship resources from both government and higher education systems, outsourcing educational services is an appropriate method, especially for colleges located in Chinese developing areas. Learning from this online program, entrepreneurship educators can move part of

entrepreneurship teaching and guidance online and use learning management systems wisely. Educators should embrace and master online teaching for the internet natives by the usage of educational technologies to meet the new requirements for teachers in the future school (Wetzel et al., 2014). A notable decline in students' learning motivation was observed over the course of eight weeks, consequently impeding their ability to successfully fulfill their practical projects within our learning management system. That is, the effectiveness of this online practical training program is bounded and should be further designed the next time. It is important to note that a practical entrepreneurship training program has a dark side for entrepreneurship intention and perception of learners' entrepreneurship skills because the real business world and questions are unstructured and highly uncertain (Bohlayer & Gielnik, 2023; Chang & Rieple, 2013).

Third, the European EntreComp is a well-structured entrepreneurship competence framework, all-encompassing and user-friendly for decision-making. Educators and individuals, however, cannot use directly it to evaluate learners' entrepreneurship competence on the basis of our EE experience. The summarized entrepreneurship competence from individual aspects, *entrepreneurial position* and *personality traits*, are assessed relatively easily. Psychology scales might be appropriate to analyze personality traits level. *Personality traits*, such as self-efficacy and creativity, are stable over time (Silveyra et al., 2021) so the change is easily found in a longitude study, hardly being improved by a short-term program. Entrepreneurial position competence can support problem/solution fit and product/market fit, standing in an entrepreneur's role. Entrepreneurship literacy is one element of 21st-century citizens, that is, learners should acquire entrepreneurship competence for their individual life and work. Educators and their stakeholders should encourage individuals to learn and master entrepreneurship competence that improves the personal economic level and reduce the unemployment rate in an economic entity. We should provide the curriculum and activities of EE for learners from other studying situations and majors to cultivate entrepreneurship mindsets. Apart from entrepreneurial educators, the research on entrepreneurship competence is significantly useful for management theorists, human resource managers, and psychologists to a certain degree (Mitchelmore & Rowley, 2010). With the supposed importance of the green concept, the extension of

entrepreneurship competence will be explored and updated, keeping dynamics, not static. Meanwhile, digital ventures and digital transformation require digital talents. This research goes further to analyze digital entrepreneurship competence which we still need to build a robust model for performance assessment, discussed in the next paragraph.

Fourth, under the drastic development of digital entrepreneurship theories and practices, digital entrepreneurship competence is seldom mentioned but essential for (would-be) entrepreneurs and stakeholders who expect a scientific assessment tool to know their competence levels (Kraus et al., 2018; Zhai et al., 2023). The results found the existing EmDigital framework should be modified based on users' requirements. As an example, *motivation and perseverance* were grouped with *management and safety*, which was an inappropriate and rough classification. In light of the fourth study application in practice, the EmDigital framework has several aspects that should be further discussed: 1) Which requirement degree of digital competence? For example, the digital section mentioned digital identity and safety which is basic digital competence. Founders of digital start-ups should be specialists in any one or two of these areas: management, marketing, law, engineering, or computer science. That is the reason the co-founders' digital competence requirements are at a low level. However, digital products or services are usually competitive/comparative advantages for digital startups. As a result, digital literacy in the EmDigital framework should set higher and detailed objectives. 2) Indicators should be set with various levels. Compared to the EU EntreComp, EmDigital lacks well-structured criteria to evaluate certain competence. If possible, each sub-competence of EmDigital should be set to five or more levels from novice to expert. It is necessary that learners, educators, and policymakers identify individual and intuitions' digital entrepreneurship competence. 3) Definition of each indicator should be further interpreted. The given indicators cannot be used directly yet in empirical studies since the explanation of indicators is still blurred and the terminologies should be further deliberated. For example, we cannot find a clear explanation of digital entrepreneurship identity in their English and Spanish publications. Therefore, this EmDigital framework is applicable as a supply tool, not the sole one when we assess learners' digital entrepreneurship competence. This experience might stimulate our counterparts to further think about how to assess

digital entrepreneurship competence and even construct a new model or scale based on previous work.

Lastly, in light of design thinking and its variants, our entrepreneurship learning management system set core steps to fill in and provide tool sets, i.e., business model canvas and value proposition canvas, for the assessment of learners' entrepreneurship ideas in the fourth study. Students need to verify and irritate their ideas by instantly contacting customers in practice, as well as marketing strategies. To narrow the gap between tool sets and their application (Gifford, 2021), each step is attached with concise explanations on the mobile application and website. Plus, the mentor recorded an introduction video that interpret the setting reason for each step and how to fill in with an example. However, this is still confusing for students who have no basic entrepreneurial knowledge and with learning burdens from their enrolled schools. Students need extra support and encouragement from mentors and tutors to maintain a high learning motivation level. There is an idea that instructors guide students to complete the main steps in an exercise course, rather than doing all steps by themselves. On the one hand, learners can learn within and between groups efficiently and effectively. The common questions can be explained in advance in front of all learners. On the other hand, instructors should nudge learners to complete their projects on time and keep them in progress. Therefore, extra guidance and supports are significantly important for distributed learners. It is noted that extra guidance is mainly provided in person. We will put lectures and guidance online in our next updated training program because of HEIs' winter break. We planned to experiment with which parts are insensitive to the learning environment in entrepreneurship experiential learning. This eight-week program is ongoing at this moment (the first two months of 2023). I and my colleagues hope that this is useful for front-line educators who work in HEIs and educational organizations to redesign their courses and teaching methods, as well as efficiently use online learning resources during new normal (the post-pandemic).

7.3 Limitation and further research

This thesis consisting of four studies provides valuable results and discussion for entrepreneurship competence and digital entrepreneurship competence in online learning environments through the adoption of educational technologies. The specific

limitation of each study has been pointed out in the corresponding chapter. Here I summarize the limitation and discuss further research in this field.

7.3.1 Educational technology in online entrepreneurship education

The first study reviewed educational technology applied in online and blended EE through browsing multiple databases. The findings showcased that social media, serious games, and digital platforms are widely applied in EE. Social media supplement online and F2F education (Tess, 2013), especially increasing in Chinese HEIs (Xue & Churchill, 2022). Video social media with high media richness can be further used in EE compared with the low richness, in particular communication of online and blended learning. The systematic review has no clear content and theoretical frameworks about the application and effectiveness of serious games such as immersion, fantasy, learning-play design, human-computer interaction, and gameplay (Deterding et al., 2011; Girard et al., 2013), or reviewing through fidelity, verification, and validation (Fox et al., 2018). Apart from experimenting with the effectiveness of certain games, (the first three levels in Table 7-1), mechanics of gamification in EE should be included and further studied (Behl et al., 2022; Ho & Chen, 2023). Implementing gamification in an online learning context improves learning motivation and engagement, as well as stimulates constructive learning (Behl et al., 2022; Taşkın & Kılıç Çakmak, 2022).

Table 7-1 Levels of Game Design Elements (Cf. Deterding et al., 2011)

Level	**Description**	**Example**
Game interface design patterns	Common, successful interaction design components and design solutions for a known problem in a context, including prototypical implementations	Badge, leader board, level
Game design patterns and mechanics	Commonly reoccurring parts of the design of a game that concern gameplay	Time constraint, limited resources, turns
Game design principles and heuristics	Evaluative guidelines to approach a design problem or analyse a given design solution	Enduring play, clear goals, variety of game styles
Game models	Conceptual models of the components of games or game experience	MDA; challenge, fantasy, curiosity; game design atoms; CEGE
Game design methods	Game design-specific practices and processes	playtesting, play centric design, value conscious game design

Digital platforms provide asynchronous recorded tutorials and additional support (Girard et al., 2013). With video devices, educators can supplement traditional EE with

synchronous live-stream teaching (van Bonn et al., 2022). ICT is a basis for digital entrepreneurship to communicate and connect with customers and stakeholders on digital platforms (Oumlil & Juiz, 2018). To know how the effectiveness of ICT in EE, the third study further investigated it in virtual team learning. However, this study has three limitations to be avoided in future research. Firstly, convenient sampling was adopted, not random, which might bring sampling bias, although we tried to collect data from different levels of universities and colleges. Secondly, we only captured data one time and respondents were staying at different periods of online entrepreneurship learning (in the middle of the course or end of the course). Although they attend the same course, namely the introduction of entrepreneurship, course objectives are varied and learners' involvement in virtual team learning stays at different levels. We hardly say the results originated from virtual team learning. Controlling those explicit and implicit variables is necessary since they impact research of scientific. Lastly, the validity and reliability of the self-designed questionnaire should be further verified. Therefore, further research should reconsider the study design and conduct an experiment with certain educational technology used in one online EE course. This research might be more meaningful for entrepreneurial theory and practice. Here are possible questions to be answered:

1. How to use social media (WeChat and Lark) effectively for an online entrepreneurship training program?
2. What are the elements and mechanisms of gamification in an online entrepreneurship training program?
3. Is there a statistically significantly different between teams of F2F collaboration and teams of online collaboration for gaining digital entrepreneurship competence?
4. How to design and run an adaptive learning management system for digital entrepreneurship competence?

The online entrepreneurship training program will conduct four times each year in online and blended learning environments. Depending on their interests, learners will be grouped into a team with three or four members to complete a digital project together online or blended. The teacher group uses social media (e.g., WeChat and Lark), digital platforms (self-designed learning management system and existing free

platform), and gamification (e.g., games and pitch competitions) to stimulate learning motivation and engagement.

7.3.2 AI in EE

Limited by existing high-quality publications, the scoping review cannot explore how to use AI in EE in detail. Thus, we did not include AI for entrepreneurship analytics as including search criteria, although there are a few pieces of literature. Regarding EE, AI can be further analyzed from two aspects: entrepreneurship and education. From entrepreneurship aspects, future research might expand the search strings and remove education/learning/teaching. In light of the summarization of AI applied entrepreneurship research and practice by Obschonka and Audretsch (2020), we can use machine learning and big data in practice, as a method or tool, to predict the commercial performance of entrepreneurial projects (Kwilinski et al., 2021), entrepreneurial finance (Antretter et al., 2019; Kwilinski et al., 2021), even scholars analyzed entrepreneurs' mental health (Williamson et al., 2022). Based on my academic background and previous research experience, as well as the existing research gap, the study of student entrepreneurs is one of further research. However, the current studies of student entrepreneurs or would-be/nascent entrepreneurs focus their entrepreneurial intention on psychology, sociology, and other fields (e.g., Iwu et al., 2021). We want to know about the survival of venture creation among nascent or would-be entrepreneurs because of their high failure rate, especially digital startups. This is a necessary and urgent theme when they have an entrepreneurial intention and they need to consider the risks and uncertainty which is the nature of digital venture creation endeavors. Therefore, inspired by AI, the following three questions are pointed out:

1. How to use AI to analyze digital startup survival?
2. Does AI predict digital startup survival efficiently?
3. Which algorithm is best for predicting students' digital entrepreneurial projects?

From the education aspect, entrepreneurial educators should learn more from the educational field and instruction design combined with this intelligent technology. The second research showcased that AI is mainly used in teaching (*N* = 7), less mentioned in learning (*N* = 3), and management (*N* = 1). Entrepreneurial educators should pay

attention to learners and learning by use of big data and learning analytics (Gašević et al., 2015). The educators capture and interpret multimodal data (e.g., eye-tracking and emotion recognition), not individual data, to trace behavioral trajectories and predict learning performance in online and F2F learning environments (Sharma & Giannakos, 2020; Yang et al., 2018). AI can be used in learning management systems, building adaptive or personalized systems, to assess and provide personalized learning content and homework (both individualized and standardized text or audio). In regard to narrowed collection criteria, we removed AI applied in entrepreneurship and focus on EE in the second study. Our data size (N = 11) is limited and compared data is narrowed into ten. The data size of the latter can be extended because we can find published high-quality research in other education fields that is much more than the former at present. Furthermore, the practice of AI applications is mature and gives hints for EE. AI can enable other educational technologies mentioned in 7.3.2. As mentioned in Study 2, natural language processing and a chatbot can be combined with an adaptive/ personalized entrepreneurship learning management system, which is less developed in this field. Here I try to analyze how to use intelligent technologies in entrepreneurship learning and teaching following fronts:

1. How to capture and interpret multimodal EE data?
2. How to advance learner-centered online EE through intelligent technologies?
3. What elements consist of an effective entrepreneurial adaptive/personalized entrepreneurship learning management system?
4. How do educators and learners use adaptive/personalized entrepreneurship learning management systems effectively?
5. Our existing entrepreneurship learning management system (mobile and website) will continue to be updated based on entrepreneurial pedagogy and educational technology theories.

7.3.3 Online experiential entrepreneurship training program

The online practical entrepreneurship training program is designed by one experienced serial entrepreneur as a commercial product that is sold to Chinese universities and colleges. Course designers adopted an experiential learning method accompanied by experiencing online synchronous tutorials, reflecting on individual and team project reflection, and doing team projects together. Since the universities need to pay for the

training program, they recommend a limited number of excellent-performance learners. Although the attendees have many common points, their learning backgrounds and learning levels are varied, making learning objectives and learning needs vary (Baasanjav, 2013). The eight weeks program cannot meet all learning interests. Therefore, when hiring candidates, the teacher group should explain the learning content outline and share a snapshot of our lecture. The fourth study analyzed a questionnaire survey with descriptive statistics to assess and self-assess all participants, which might be inaccurate. The course duration is eight weeks and we gathered data one time directly. The student interviewees might give biased opinions. So, we plan to collect data two times, before and after the training program, to compare the difference. In addition, the interview outline of the fourth study set limited questions (six questions) relevant to digital entrepreneurship competence. I will set more interview questions for each sub-competence to gather information and ideas in detail. The program designer should invite venture capitalists, entrepreneurs, and executives to guide their projects or attend the final presentation to evaluate their pitches at the last class. Learning content, especially the digital part should be updated on basis of technology trends.

Traditional venture creation happens in a specific physical place constrained by social culture and institutional environment (Stam & Welter, 2020). Digital entrepreneurship is less relevant to the spatial. Digital EE and training easily move into the online context in contrast with traditional entrepreneurship. Entrepreneurial educators mainly keep experiential learning in F2F settings. Practical learning, action-orientation learning, learning by doing, and experiential learning can be interchanged in my future research. This experimental learning with four stages originates from Dewey, Lewinian, and Piaget. The experiential learning cycle designed by Kolb is active learning where students are involved and applied in business courses (Motta & Galina, 2023). In light of the overview of 37 action-based entrepreneurship training publications by Bohlayer and Gielnik (2023), there is only one training program conducted online and we cannot find data from China where EE booms in the past eight years, namely, research results on online experiential entrepreneurship training are rare (e.g., McFarland, 2017; Mensah et al., 2022), especially from China (e.g., Bell, 2020). Online experiential learning amplifies the existing difficulty of a team working with limitations of spatial

(Motta & Galina, 2023). With regard to the Community of Inquiry, experiential learning in online environments should facilitate teacher-learner, learner-learner, and learner-content interactions (Garrison & Arbaugh, 2007). Looking back on the first two versions of the training program, the remote mentor gave tutorials and tutored learners‘ projects only one time by writing down his suggestions. Without meeting in person to know each other in-depth, team members executed tasks toughly. Interactive learning methods, not only passively listening to lectures, should be used to facilitate active learning for distributed learners (Kosslyn, 2021). Therefore, we will provide an extra chance to ask questions to the mentor through online individual guidance per week. The tutors and learners come from the same institutions and the tutors can organize F2F meetings, even learners attend the online lecture together in one brick-and-mortar classroom where they also design and make prototypes. They can exchange ideas and information asynchronously and synchronously beyond the classroom and campus. Learners can log in on mobile learning management systems to complete their tasks anytime and anywhere. Lectures and individual guidance will be recorded and the questions are transferred into text for learners’ further learning.

There is remarkably little (if any) practical evidence on experiential learning in online entrepreneurship training programs. The study did not classify the four segmentations of experiential learning clearly (Mason & Arshed, 2013). Additionally, scholars should adopt quantitative data, as well as interviewing and reflective data. Therefore, we will distribute an online questionnaire survey, apart from text feedback and interviews on the online entrepreneurship training program. Because of the simulation of the real world, we might analyze the effectiveness of online projects based on Kolb‘s experiential learning consisting of concrete experience, observation, conceptualization, and active experimentation (Kolb, 2014). Concrete experience in this research contains activities of the designation of digital products or services including digital content (e.g., videos, podcasts, books), digital applications or software (e.g., video games, websites, social media), and Web3 (e.g., blockchain, non-fungible token). The further program will introduce AI-generated content. Reflective observation is individual and group reflection on the project experience. Learners contextualize entrepreneurship concepts, principles, and ideas during the conceptual period. The final is actively starting new practices with the adoption of learned knowledge/skills or suggestions for further

action (Farber et al., 2015; Motta & Galina, 2023).

Business models and business planning depend on causation and assumptions (Jones, 2011) whereas effectuation is vice versa (Sarasvathy, 2009). The future experiential learning activities obey principles of effectuation, design thinking, and lean startup. Participants should design and validate a digital prototype of their product or service with their members during the eight weeks, report their process weekly, and pitch them, as well as write a weekly reflection. Hence, a series of experiential entrepreneurship training programs are conducted and the program is updated each time. The future research questions are thereafter:

1. How to provide an efficient online entrepreneurship training program?
2. How can educators tutor online experiential training for distributed learners?
3. What preparations can learners do when attend an online experiential training program?
4. How is the online experiential entrepreneurship training program for concrete experience/ reflective observation/ abstract conceptualization/ active experimentation?
5. Which section (concrete experience, reflective observation, abstract conceptualization, or active experimentation) of experiential learning can be improved in an online experiential entrepreneurship training program?

7.3.4 Assessment of digital entrepreneurship competence

The fourth study captured quantitative and qualitative data to assess digital entrepreneurship competence. I made use of the existing EntreComp framework and EmDigtial framework to assess learners enrolled in Chinese HEIs. The former framework is general for educators to adopt in daily entrepreneurship teaching. The latter provides a set of indicators and users still need to develop a scale. Although we searched Spanish and English publications and videos, as well as sent emails to framework designers (without response), our understanding of each indicator might be inaccurate. Furthermore, double-checked by my Chinese colleagues, the English-Chinese translation of indicators of the digital entrepreneurship competence framework might lose important information.

I interviewed learners and tutors to know how digital entrepreneurship competence changed during the eight weeks. I also distributed questionnaires to gain quantitative data. However, we lack prior entrepreneurship competence information. Additionally, the application of the EmDigital framework is limited by the collected data of the fourth study. Four tutors' opinions are suggestive whereas learners had less experience in entrepreneurship theories and practices. Around eighty percent of interviewees (*N* = 15) are students and they have no or little entrepreneurship knowledge and experience. Thus, all participants' opinions on this program might be biased since only one tutor has his own company and one tutor launched an e-business before. If possible, we can invite more tutors and gather their assessment of learners' digital entrepreneurship competence. Therefore, further research is conducted and ongoing to compare before and after one eight-week online practical entrepreneurship training program, without F2F or blended learning. The ongoing program invited more tutors (*N* = 17) than before (*N* = 4) to support 93 distributed learners. Different from the fourth study, the following interview will focus on digital entrepreneurship competence without the attitudes toward the training program. I plan to invite more tutors coming from various schools of universities when the training program ends. Both interview and prior-post survey aims to know students' changes in digital entrepreneurship competence, supplied by individual reflections and team projects. The new version program has been started and we already collected the prior self-report data through a questionnaire survey (*N* = 56) after a kick-out lecture on January 3, 2023. To stimulate and monitor their process, tutors already have asked students to present their projects online two times in the past first two weeks from January 3, 2023, to January 17, 2023. We shared information in our social media group to keep in touch. We will contact respondents one by one based on the first-named questionnaire to confirm they fill in the post-survey and send an interview invitation. There is a pity that it is impossible for us to find compared groups to control variants. However, all learners attend this lecture and get guidance remotely, as well as avoid other factors (e.g., other entrepreneurship activities) from their enrolled schools, since there is two months winter holiday in Chinese HEIs.

Regarding the built EmDigital Framework and the experience from the fourth study, we will separate management and safety into two sub-competencies. So, the next research will assess opportunity identification, action planning, management, collaboration, and

safety separately. Therefore, the questionnaire used in Study 4 can be further used in the next research with a tiny modification on narration, in order to test the following hypothesis:

1. Opportunity identification is improved through an online experiential entrepreneurship training program.
2. Management competence is improved through an online experiential entrepreneurship training program.
3. Action planning competence is improved through an online experiential entrepreneurship training program.
4. Safety competence is improved through an online experiential entrepreneurship training program.

When I searched for indicators and scales for the assessment of digital entrepreneurship competence in English and Chinese, a scientific digital entrepreneurship competence scale or questionnaire exists in both research and practice gaps. Assessment of participants' digital entrepreneurship competence can learn from that of entrepreneurship competence. The existing measurement methods of entrepreneurship competence are self-assess scales, case studies, and in-depth interviews (Mitchelmore & Rowley, 2010; Sieger et al., 2016). Indicators of scales depend on the scholar's own definition of entrepreneurship competence. Scale designation and development is a need for entrepreneurial learners, educators, and policymakers. For example, similar to psychological testing, a scientific digital entrepreneurship competence scale can help learners know whether self-employment is appropriate for them briefly and find their shortcomings in this competence to remedy them. The digital entrepreneurship competence scale measured digital competence and entrepreneurship competence separately (e.g., Kurmanov et al., 2020). To know learners' learning levels and give further suggestions after our teaching, I and my Chinese colleagues plan to develop, test, and validate a new scale measuring digital entrepreneurship competence for ourselves and our counterparts.

The original scale will assess five sub-digital entrepreneurship competencies, including opportunity identification, action planning, management, collaboration, and safety, with regard to indicators and explanations of the EmDigital. We will systematically

search literature with existing scales for each construct. For example, the founders' social identity scale (Sieger et al., 2016) can be considered in the construct of opportunity identification. Complied by two authors, each construct has five to ten items with five points Likert scale, several being reversed coded (Vagos et al., 2019). The demographic information of age (Wang et al., 2022), gender (Wang et al., 2022), family entrepreneurial background (Hahn et al., 2020), and their own entrepreneurial experience (Miller et al., 2012) will be investigated to control. The original scale will be decided by three experts from entrepreneurship, business administration, and education. Then the scale will be discussed by the Delphi method to finalize it by interviewing learners (N = 20) and tutors (N = 30) who are participants in the online entrepreneurship training program. Then we will sample 200 Chinese tutors and learners (based on the hiring results of the first two programs) who attend our training programs and their prior-post self-report on digital entrepreneurship competence to test the instrument. We will further distribute the updated scale to undergraduates and graduates who are not in this online entrepreneurship training program but whose enrolled HEIs are members of the online training given institute. Because one of my collaborators provides EE services for 62 universities and colleges (data updated until 25 January 2023) around China, the distribution of a scientific scale is feasible and assessment of digital entrepreneurship competence is a real need that is urgent to meet for institutions and would-be entrepreneurs. The scale is not static, but dynamic and open, namely, we and our counterparts can update it as their needs. The scale will be tested and validated in the 62 Chinese HEIs and then will be translated into English and German. Therefore, the following questions of interest will be explored in our further research.

1. How can educators construct a validated scale for the measurement of digital entrepreneurship competence?
2. Is the digital entrepreneurship competence scale efficient and reliable?
3. How can educators use the digital entrepreneurship competence scale?
4. How to combine the digital entrepreneurship competence scale with interviews to know learners' learning level of digital entrepreneurship?
5. How to support active learning through the digital entrepreneurship competence scale?

6. How to use the digital entrepreneurship competence scale in cross-cultural situations?

As mentioned in Study 4, the online practical training program needs to be updated with practical guidance to make sure students can make a prototype or even launch a minimal-value product where learners probably practice their competence well. Therefore, the first further research has been decided by me and my colleague to analyze four digital entrepreneurship competencies in depth through our updated online experiential training program. The second further research has been decided to develop an effective and scientific digital entrepreneurship competence scale. I am pleased to introduce educational technologies, especially AI into our entrepreneurship learning management system to build an adaptive mobile and website entrepreneurship learning system with my entrepreneurship and technology colleagues as our near future work planning package.

7.3 Conclusion

Entrepreneurship competence has been discussed and built during the past several decades whereas digital entrepreneurship competence is less studied for digital venture creation endeavors. Entrepreneurship competence is usually gained from education, training, and personal experience (Miller et al., 2012), further delivering in online learning environments. In the digital age, educational technologies supplement online education for learners' engagement and motivation. Social media, serious games or gamification, and digital platforms are widely used in online and blended EE. With the booming development of AI, an adaptive learning management system can advance individual entrepreneurship learning on basis of design thinking and its variants. Natural language processing and the chatbot will enable entrepreneurship learning, supporting decision-making. Our empirical research proved virtual team learning with the assistance of ICT is effective for both competences of entrepreneurial positions and personality traits.

Assessment and facilitation of digital entrepreneurship competence are essential in the digital age. Digital entrepreneurship competence does not simply combine digital competence and entrepreneurship competence. The existing digital entrepreneurship competence models should be further verified. Entrepreneurial practitioners and

educators need a scientific assessment tool that I and my colleagues will design in the next research.

This research consists of quantitative and qualitative studies, theoretical and empirical designs, and online and blended learning contexts. Understanding, assessing, and facilitating of entrepreneurship competence in the digital age still require significant efforts from educators, scholars, and policy-makers. This thesis is a brief assessment of entrepreneurship competence and digital entrepreneurship competence. Significantly supported by a Chinese entrepreneurship training institution, I and my colleagues will continue to complete a series of studies mentioned in 7.3. With our continual and consistent work, we aim to facilitate the theoretical and practical development of entrepreneurship competence in both online and blended learning environments.

References

Almeida, F. (2017). Experience with Entrepreneurship Learning Using Serious Games. Cypriot Journal of Educational Sciences, 12(2), 69–80.

Antretter, T., Blohm, I., Grichnik, D., & Wincent, J. (2019). Predicting new venture survival: A Twitter-based machine learning approach to measuring online legitimacy. Journal of Business Venturing Insights, 11, e00109.

Åstebro, T., & Thompson, P. (2011). Entrepreneurs, jacks of all trades or hobos? Research Policy, 40(5), 637–649.

Baasanjav, U. (2013). Incorporating the experiential learning cycle into online classes. Journal of Online Learning and Teaching, 9(4), 575.

Backes-Gellner, U., & Moog, P. (2013). The disposition to become an entrepreneur and the jacks-of-all-trades in social and human capital. The Journal of Socio-Economics, 47, 55–72.

Behl, A., Jayawardena, N., Pereira, V., Islam, N., Del Giudice, M., & Choudrie, J. (2022). Gamification and e-learning for young learners: A systematic literature review, bibliometric analysis, and future research agenda. Technological Forecasting and Social Change, 176, 121445.

Bell, R. (2020). Adapting to constructivist approaches to entrepreneurship education in the Chinese classroom. Studies in Higher Education, 45(8), 1694–1710.

Bohlayer, C., & Gielnik, M. M. (2023). (S) training experiences: Toward understanding decreases in entrepreneurial self-efficacy during action-oriented entrepreneurship training. Journal of Business Venturing, 38(1), 106259.

Brüne, N., & Lutz, E. (2014). The effect of entrepreneurship education in schools on entrepreneurial outcomes: A systematic review. Management Review Quarterly, 70(2), 275–305.

Bublitz, E., & Noseleit, F. (2011). The skill balancing act: Determinants of and returns to balanced skills. Jena Economic Research Papers.

Chang, J., & Rieple, A. (2013). Assessing students' entrepreneurial skills development in live projects. Journal of Small Business and Enterprise Development.

Chung, E., Noor, N. M., & Mathew, V. N. (2020). Are you ready? An assessment of online learning readiness among university students. International Journal of Academic Research in Progressive Education and Development, 9(1), 301–317.

Crawford, E. R., & Lepine, J. A. (2013). A configural theory of team processes: Accounting for the structure of taskwork and teamwork. Academy of Management Review, 38(1), 32–48.

Criaco, G., Minola, T., Migliorini, P., & Serarols-Tarrés, C. (2014a). "To have and have not": Founders' human capital and university start-up survival. The Journal of Technology Transfer, 39(4), 567–593.

Criaco, G., Minola, T., Migliorini, P., & Serarols-Tarrés, C. (2014b). "To have and have not": Founders' human capital and university start-up survival. The Journal of Technology Transfer, 39(4), 567–593.

Demirbilek, M., & Talan, T. (2018). The effect of social media multitasking on classroom performance. Active Learning in Higher Education, 19(2), 117–129.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining" gamification". Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, 9–15.

Escamilla-Fajardo, P., Alguacil, M., & López-Carril, S. (2021). Incorporating TikTok in higher education: Pedagogical perspectives from a corporal expression sport sciences course. Journal of Hospitality, Leisure, Sport & Tourism Education, 28, 100302.

Etzkowitz, H. (2014). The entrepreneurial university wave: From ivory tower to global economic engine. Industry and Higher Education, 28(4), 223–232.

Farber, V. A., Prialé, M. A., & Fuchs, R. M. (2015). An entrepreneurial learning exercise as a pedagogical tool for teaching CSR: A Peruvian study. Industry and Higher Education, 29(5), 345–360.

Ferguson, C., Van den Broek, E. L., & Van Oostendorp, H. (2020). On the role of interaction mode and story structure in virtual reality serious games. Computers & Education, 143, 103671.

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.

Garrison, D. R., & Arbaugh, J. B. (2007). Researching the community of inquiry framework: Review, issues, and future directions. The Internet and Higher Education, 10(3), 157–172.

Gašević, D., Dawson, S., & Siemens, G. (2015). Let's not forget: Learning analytics are about learning. TechTrends, 59(1), 64–71.

Georgescu, M.-A., & Herman, E. (2020). The impact of the family background on students' entrepreneurial intentions: An empirical analysis. Sustainability, 12(11), 4775.

Gielnik, M. M., Frese, M., Kahara-Kawuki, A., Wasswa Katono, I., Kyejjusa, S., Ngoma, M., Munene, J., Namatovu-Dawa, R., Nansubuga, F., & Orobia, L. (2015). Action and action-regulation in entrepreneurship: Evaluating a student training for promoting entrepreneurship. Academy of Management Learning & Education, 14(1), 69–94.

Gifford, E. (2021). Theory-driven methods for practical entrepreneurship: Hypothesis testing in entrepreneurship education. Industry and Higher Education, 35(4), 497–504.

Gimmon, E., & Levie, J. (2010). Founder's human capital, external investment, and the survival of new high-technology ventures. Research Policy, 39(9), 1214–1226.

Girard, C., Ecalle, J., & Magnan, A. (2013). Serious games as new educational tools: How effective are they? A meta-analysis of recent studies. Journal of Computer Assisted Learning, 29(3), 207–219.

Graham, B., & Bonner, K. (2022). One size fits all? Using machine learning to study heterogeneity and dominance in the determinants of early-stage entrepreneurship. Journal of Business Research, 152, 42–59.

Hahn, D., Minola, T., Bosio, G., & Cassia, L. (2020). The impact of entrepreneurship education on university students' entrepreneurial skills: A family embeddedness perspective. Small Business Economics, 55(1), 257–282.

Hahn, D., Minola, T., Van Gils, A., & Huybrechts, J. (2017). Entrepreneurial education and learning at universities: Exploring multilevel contingencies. Entrepreneurship & Regional Development, 29(9–10), 945–974.

Harms, R. (2015). Self-regulated learning, team learning and project performance in entrepreneurship education: Learning in a lean startup environment. Technological Forecasting and Social Change, 100, 21–28.

Hayes, D., & Richmond, W. (2017). Using an online assessment to examine entrepreneurship student traits and to measure and improve the impact of entrepreneurship education. Journal of Entrepreneurship Education, 20(1), 88–107.

Ho, S.-C., & Chen, J.-L. (2023). Developing the e-commerce competency for entrepreneurship education from a gamified competition. The International Journal of Management Education, 21(1), 100737.

Iwu, C. G., Opute, P. A., Nchu, R., Eresia-Eke, C., Tengeh, R. K., Jaiyeoba, O., & Aliyu, O. A. (2021). Entrepreneurship education, curriculum and lecturer-competency as antecedents of student entrepreneurial intention. The International Journal of Management Education, 19(1), 100295.

Jones, C. (2011). Teaching entrepreneurship to undergraduates. In Teaching Entrepreneurship to Undergraduates. Edward Elgar Publishing.

Kokoç, M. (2021). The mediating role of attention control in the link between multitasking with social media and academic performances among adolescents. Scandinavian Journal of Psychology, 62(4), 493–501.

Kolb, D. A. (2014). Experiential learning: Experience as the source of learning and development. FT press.

Kosslyn, S. M. (2021). Active learning online: Five principles that make online courses come alive. Alinea Learning.

Kraus, S., Palmer, C., Kailer, N., Kallinger, F. L., & Spitzer, J. (2018). Digital entrepreneurship: A research agenda on new business models for the twenty-first century. International Journal of Entrepreneurial Behavior & Research.

Kurmanov, N., Aliyeva, Z., Kabdullina, G., & Mutaliyeva, L. (2020). Digital entrepreneurship competencies among students: Methodological aspects of the maturity level and development program making. Journal of Entrepreneurship Education, 23(2), 1–11.

Kwilinski, A., Litvin, V., Kamchatova, E., Polusmiak, J., & Mironova, D. (2021). Information support of the entrepreneurship model complex with the application of cloud technologies. International Journal of Entrepreneurship, 25(1), 1–8.

Landers, R. N., Auer, E. M., Collmus, A. B., & Armstrong, M. B. (2018). Gamification science, its history and future: Definitions and a research agenda. Simulation & Gaming, 49(3), 315–337.

Lazear, E. P. (2004). Balanced skills and entrepreneurship. American Economic Review, 94(2), 208–211.

Liu, M., Gorgievski, M. J., Qi, J., & Paas, F. (2022). Increasing teaching effectiveness in entrepreneurship education: Course characteristics and student needs differences. Learning and Individual Differences, 96, 102147.

Marques, C. S., Santos, G., Galvão, A., Mascarenhas, C., & Justino, E. (2018). Entrepreneurship education, gender and family background as antecedents on the entrepreneurial orientation of university students. International Journal of Innovation Science.

Martin, F., Sun, T., & Westine, C. D. (2020). A systematic review of research on online teaching and learning from 2009 to 2018. Computers & Education, 159, 104009.

Mason, C., & Arshed, N. (2013). Teaching entrepreneurship to university students through experiential learning: A case study. Industry and Higher Education, 27(6), 449–463.

Matthews, C. H., & Moser, S. B. (1996). A longitudinal investigation of the impact of family background. Journal of Small Business Management, 34(2), 29–43.

McFarland, K. (2017). Entrepreneurship Education and Experiential E-Learning: A Literature Review. Developments in Business Simulation and Experiential Learning: Proceedings of the Annual ABSEL Conference, 44.

Mensah, M. S., Arthur, K. N., & Mensah-Williams, E. (2022). Experiential Learning in Online Entrepreneurship Education: Lessons from an Undergraduate Entrepreneurship Course. In Theorising Undergraduate Entrepreneurship Education (pp. 333–351). Springer.

Miller, T. L., Wesley, C. L., & Williams, D. E. (2012). Educating the minds of caring hearts: Comparing the views of practitioners and educators on the importance of social entrepreneurship competencies. Academy of Management Learning & Education, 11(3), 349–370.

Mitchelmore, S., & Rowley, J. (2010). Entrepreneurial competencies: A literature review and development agenda. International Journal of Entrepreneurial Behavior & Research.

Motta, V. F., & Galina, S. V. R. (2023). Experiential learning in entrepreneurship education: A systematic literature review. Teaching and Teacher Education, 121, 103919.

Obschonka, M., & Audretsch, D. B. (2020). Artificial intelligence and big data in entrepreneurship: A new era has begun. Small Business Economics, 55(3), 529–539.

Oumlil, R., & Juiz, C. (2018). Acceptance of tourism e-entrepreneurship: Application to educational Balearic Islands Context. Journal of Entrepreneurship Education, 21(1), 1–16.

Palmer, C., Fasbender, U., Kraus, S., Birkner, S., & Kailer, N. (2021). A chip off the old block? The role of dominance and parental entrepreneurship for entrepreneurial intention. Review of Managerial Science, 15(2), 287–307.

Pimmer, C., Brühlmann, F., Odetola, T. D., Oluwasola, D. O., Dipeolu, O., & Ajuwon, A. J. (2019). Facilitating professional mobile learning communities with instant messaging. Computers & Education, 128, 102–112.

Remold, S. (2012). Understanding specialism when the jack of all trades can be the master of all. Proceedings of the Royal Society B: Biological Sciences, 279(1749), 4861–4869.

Robledo, S., Grisales Aguirre, A. M., Hughes, M., & Eggers, F. (2021). "Hasta la vista, baby"–will machine learning terminate human literature reviews in entrepreneurship? Journal of Small Business Management, 1–30.

Sabahi, S., & Parast, M. M. (2020). The impact of entrepreneurship orientation on project performance: A machine learning approach. International Journal of Production Economics, 226, 107621.

Sarasvathy, S. D. (2009). Effectuation: Elements of entrepreneurial expertise. Edward Elgar Publishing.

Schade, P., & Schuhmacher, M. C. (2023). Predicting entrepreneurial activity using machine learning. Journal of Business Venturing Insights, 19, e00357.

Schmitz, A., Urbano, D., Dandolini, G. A., de Souza, J. A., & Guerrero, M. (2017). Innovation and entrepreneurship in the academic setting: A systematic literature review. International Entrepreneurship and Management Journal, 13, 369–395.

Scuotto, V., & Morellato, M. (2013). Entrepreneurial knowledge and digital competence: Keys for a success of student entrepreneurship. Journal of the Knowledge Economy, 4, 293–303.

Sharma, K., & Giannakos, M. (2020). Multimodal data capabilities for learning: What can multimodal data tell us about learning? British Journal of Educational Technology, 51(5), 1450–1484.

Sieger, P., Gruber, M., Fauchart, E., & Zellweger, T. (2016). Measuring the social identity of entrepreneurs: Scale development and international validation. Journal of Business Venturing, 31(5), 542–572.

Silveyra, G., Herrero, Á., & Pérez, A. (2021). Model of teachable entrepreneurship competencies (M-TEC): Scale development. The International Journal of Management Education, 19(1), 100392.

Smutny, P., & Schreiberova, P. (2020). Chatbots for learning: A review of educational chatbots for the Facebook Messenger. Computers & Education, 151, 103862.

Stam, E., & Welter, F. (2020). Geographical contexts of entrepreneurship: Spaces, places and entrepreneurial agency. In The Psychology of Entrepreneurship (pp. 263–281). Routledge.

Taşkın, N., & Kılıç Çakmak, E. (2022). Effects of gamification on behavioral and cognitive engagement of students in the online learning environment. International Journal of Human–Computer Interaction, 1–12.

Teng, T.-L., & Taveras, M. (2004). Combining live video and audio broadcasting, synchronous chat, and asynchronous open forum discussions in distance education. Journal of Educational Technology Systems, 33(2), 121–129.

Tess, P. A. (2013). The role of social media in higher education classes (real and virtual)–A literature review. Computers in Human Behavior, 29(5), A60–A68.

Thanasi-Boçe, M. (2020). Enhancing students' entrepreneurial capacity through marketing simulation games. Education+ Training.

Thomas, N. J., & Baral, R. (2023). Mechanism of gamification: Role of flow in the behavioral and emotional pathways of engagement in management education. The International Journal of Management Education, 21(1), 100718.

Thormann, J., & Fidalgo, P. (2014). Guidelines for online course moderation and community building from a student's perspective. Journal of Online Learning & Teaching, 10(3), 374–388.

Vagos, P., Rodrigues, P. F., Pandeirada, J. N., Kasaeian, A., Weidenauer, C., Silva, C. F., & Randler, C. (2019). Factorial structure of the Morningness-Eveningness-Stability-Scale (MESSi) and sex and age invariance. Frontiers in Psychology, 10, 3.

van Bonn, S. M., Grajek, J. S., Schneider, A., Oberhoffner, T., Mlynski, R., & Weiss, N. M. (2022). Interactive live-stream surgery contributes to surgical education in the context of contact restrictions. European Archives of Oto-Rhino-Laryngology, 279(6), 2865–2871.

Wagner, J. (2003). Testing Lazear's jack-of-all-trades view of entrepreneurship with German micro data. Applied Economics Letters, 10(11), 687–689.

Wang, C., Mundorf, N., & Salzarulo-McGuigan, A. (2022). Entrepreneurship education enhances entrepreneurial creativity: The mediating role of entrepreneurial inspiration. The International Journal of Management Education, 20(2), 100570.

Wetzel, K., Buss, R., Foulger, T. S., & Lindsey, L. (2014). Infusing educational technology in teaching methods courses: Successes and dilemmas. Journal of Digital Learning in Teacher Education, 30(3), 89–103.

Williamson, A. J., Drencheva, A., & Battisti, M. (2022). Entrepreneurial disappointment: Let down and breaking down, a machine-learning study. Entrepreneurship Theory and Practice, 46(6), 1500–1533.

Xue, S., & Churchill, D. (2022). Educational affordances of mobile social media for language teaching and learning: A chinese teacher's perspective. Computer Assisted Language Learning, 35(4), 918–947.

Yang, D., Alsadoon, A., Prasad, P. C., Singh, A. K., & Elchouemi, A. (2018). An emotion recognition model based on facial recognition in virtual learning environment. Procedia Computer Science, 125, 2–10.

Yang, Y., Cho, Y., Mathew, S., & Worth, S. (2011). College student effort expenditure in online versus face-to-face courses: The role of gender, team learning orientation, and sense of classroom community. Journal of Advanced Academics, 22(4), 619–638.

Zhai, X. (2022). ChatGPT User Experience: Implications for Education. Available at SSRN 4312418.

Zhai, Y., Yang, K., Chen, L., Lin, H., Yu, M., & Jin, R. (2023). Digital entrepreneurship: Global maps and trends of research. Journal of Business & Industrial Marketing, 38(3), 637–655.

Zhonggen, Y. (2019). A meta-analysis of use of serious games in education over a decade. International Journal of Computer Games Technology, 2019.

Complete list of references

Acs, Z., Szerb, L., & Autio, E. (2018). The Global Entrepreneurship Index. In Z. Acs, L. Szerb, & E. Autio, Global Entrepreneurship and Development Index 2018 (pp. 19–38). Springer International Publishing. https://doi.org/10.1007/978-3-319-63844-7_3

Adamopoulou, E., & Moussiades, L. (2020). An overview of chatbot technology. IFIP International Conference on Artificial Intelligence Applications and Innovations, 373–383.

Agudo-Peregrina, Á. F., Iglesias-Pradas, S., Conde-González, M. Á., & Hernández-García, Á. (2014). Can we predict success from log data in VLEs? Classification of interactions for learning analytics and their relation with performance in VLE-supported F2F and online learning. Computers in Human Behavior, 31, 542–550. https://doi.org/10.1016/j.chb.2013.05.031

Ahmad, S. F., Rahmat, M., Mubarik, M. S., Alam, M. M., & Hyder, S. I. (2021). Artificial Intelligence and Its Role in Education. Sustainability, 13(22), 12902.

Ahmed, C. of A. C. with E. A. I. A. S. on L. M. S. for E. E., & Ganapathy, A. (2021). Creation of Automated Content with Embedded Artificial Intelligence: A Study on Learning Management System for Educational Entrepreneurship. Academy of Entrepreneurship Journal, 27(3), 1–10.

Ahmed, M. A., Khattak, M. S., & Anwar, M. (2022). Personality traits and entrepreneurial intention: The mediating role of risk aversion. Journal of Public Affairs, 22(1), e2275.

Ajjan, H., & Hartshorne, R. (2008). Investigating faculty decisions to adopt Web 2.0 technologies: Theory and empirical tests. The Internet and Higher Education, 11(2), 71–80. https://doi.org/10.1016/j.iheduc.2008.05.002

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Al-Atabi, M., & DeBoer, J. (2014). Teaching entrepreneurship using massive open online course (MOOC). Technovation, 34(4), 261–264.

Aldrich, H. E. (1990). Using an ecological perspective to study organizational founding rates. Entrepreneurship Theory and Practice, 14(3), 7–24.

Aldrich, H. E., & Fiol, C. M. (1994). Fools rush in? The institutional context of industry creation. Academy of Management Review, 19(4), 645–670.

Al-Emran, M., Mezhuyev, V., & Kamaludin, A. (2018). Technology Acceptance Model in M-learning context: A systematic review. Computers & Education, 125, 389–412.

Alenezi, H. S., & Faisal, M. H. (2020). Utilizing Crowdsourcing and Machine Learning in Education: Literature Review. Education and Information Technologies, 25(4), 2971–2986. https://doi.org/10.1007/s10639-020-10102-w

Ali, M. M., Hashim, N., & Ibrahim, A. (2018). The evaluations of facebook as an educational technology tools in polytechnic's entrepreneurship courses. Journal of Fundamental and Applied Sciences, 9(6S), 805. https://doi.org/10.4314/jfas.v9i6s.60

Alkhalil, A., Abdallah, M. A. E., Alogali, A., & Aljaloud, A. (2021). Applying big data analytics in higher education: A systematic mapping study. International Journal of Information and Communication Technology Education (IJICTE), 17(3), 29–51.

Allan, J., & Lawless, N. (2003). Stress caused by on-line collaboration in e-learning: A developing model. Education + Training, 45(8), 564–572. https://doi.org/10.1108/00400910310508955

Allen, I. E. & Seaman, J. (2008). Staying the course: Online Education in the United States, 2008. In Ultrasound in Obstetrics and Gynecology (Vol. 21, Issue 1). https://doi.org/10.1002/uog.35

Allen, J. P. (2019). Digital entrepreneurship. Routledge.

Allen, J. S., Stevenson, R. M., O'Boyle, E. H., & Seibert, S. (2021). What matters more for entrepreneurship success? A meta-analysis comparing general mental ability

and emotional intelligence in entrepreneurial settings. Strategic Entrepreneurship Journal, 15(3), 352–376.
Almasri, A., Ahmed, A., Almasri, N., Abu Sultan, Y. S., Mahmoud, A. Y., Zaqout, I. S., Akkila, A. N., & Abu-Naser, S. S. (2019). Intelligent tutoring systems survey for the period 2000-2018.
Almeida, F. L. (2017). Experience with entrepreneurship learning using serious games. Cypriot Journal of Educational Sciences, 12(2), 69–80. https://doi.org/10.18844/cjes.v12i2.1939
Almeida, F., Santos, J. D., & Monteiro, J. A. (2014). e-commerce business models in the context of web3. 0 paradigm. ArXiv Preprint ArXiv:1401.6102.
Alon, I., & Herath, R. K. (2014). Teaching International Business via Social Media Projects. Journal of Teaching in International Business, 25(1), 44–59. https://doi.org/10.1080/08975930.2013.847814
Alvarez, S. A., & Barney, J. B. (2010). Entrepreneurship and epistemology: The philosophical underpinnings of the study of entrepreneurial opportunities. Academy of Management Annals, 4(1), 557–583.
An, C., Park, Y. W., Ahn, S. S., Han, K., Kim, H., & Lee, S.-K. (2021). Radiomics machine learning study with a small sample size: Single random training-test set split may lead to unreliable results. PloS One, 16(8), e0256152.
Andersén, J., & Ljungkvist, T. (2021). Resource orchestration for team-based innovation: A case study of the interplay between teams, customers, and top management. R&D Management, 51(1), 147–160. https://doi.org/10.1111/radm.12442
Anderson, M., & Jiang, J. (n.d.). Teens, Social Media & Technology 2018. 10.
Anderson, T. (2004). Teaching in an online learning context. Theory and Practice of Online Learning, 273.
Antonaci, A., Dagnino, F. M., Ott, M., Bellotti, F., Berta, R., De Gloria, A., Lavagnino, E., Romero, M., Usart, M., & Mayer, I. (2015). A gamified collaborative course in entrepreneurship: Focus on objectives and tools. Computers in Human Behavior, 51, 1276–1283. https://doi.org/10.1016/j.chb.2014.11.082
Antretter, T., Blohm, I., Grichnik, D., & Wincent, J. (2019). Predicting new venture survival: A Twitter-based machine learning approach to measuring online legitimacy. Journal of Business Venturing Insights, 11, e00109.
Archer, G. R., & Axe, J. (2010). Social media engages online entrepreneurship students. Cutting-Edge Social Media Approaches to Business Education: Teaching with LinkedIn, Facebook, Twitter, Second Life, and Blogs., 159–177.
Ardichvili, A., Cardozo, R., & Ray, S. (2003). A theory of entrepreneurial opportunity identification and development. Journal of Business Venturing, 18(1), 105–123.
Arias, E., Barba-Sánchez, V., Carrión, C., & Casado, R. (2018). Enhancing Entrepreneurship Education in a Master's Degree in Computer Engineering: A Project-Based Learning Approach. Administrative Sciences, 8(4), 58. https://doi.org/10.3390/admsci8040058
Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. International Journal of Social Research Methodology, 8(1), 19–32. https://doi.org/10.1080/1364557032000119616
Arshi, T. A., Islam, S., & Gunupudi, N. (2021). Predicting the effect of entrepreneurial stressors and resultant strain on entrepreneurial behaviour: An SEM-based machine-learning approach. INTERNATIONAL JOURNAL OF ENTREPRENEURIAL BEHAVIOR & RESEARCH, 27(7), 1819–1848. https://doi.org/10.1108/IJEBR-08-2020-0529
Åstebro, T., & Thompson, P. (2011). Entrepreneurs, jacks of all trades or hobos? Research Policy, 40(5), 637–649.
Atkinson, A. B. (2019). Measuring poverty around the world. In Measuring Poverty around the World. Princeton University Press.
Awwad, M. S., & Al-Aseer, R. M. N. (2021). Big five personality traits impact on entrepreneurial intention: The mediating role of entrepreneurial alertness. Asia Pacific Journal of Innovation and Entrepreneurship.
Baasanjav, U. (2013). Incorporating the experiential learning cycle into online classes. Journal of Online Learning and Teaching, 9(4), 575.

Babatunde, S., El-Gohary, H., & Edwards, D. (2021). Assessment methods in entrepreneurship education, challenges and opportunities in developed and developing nations: A comparative study of Nigeria and England. Education+ Training..

Bacigalupo, M., Kampylis,P., P., Punie, Y., & Van den Brande, G. (2016). EntreComp: The entrepreneurship competence framework. Publications Office. https://data.europa.eu/doi/10.2791/593884

Backes-Gellner, U., & Moog, P. (2013). The disposition to become an entrepreneur and the jacks-of-all-trades in social and human capital. The Journal of Socio-Economics, 47, 55–72.

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

Baig, U., Hussain, B. M., Meidute-Kavaliauskiene, I., & Davidavicius, S. (2022). Digital Entrepreneurship: Future Research Directions and Opportunities for New Business Model. Sustainability, 14(9), 5004.

Baker, R. S. J. d., Corbett, A. T., Koedinger, K. R., Evenson, S., Roll, I., Wagner, A. Z., Naim, M., Raspat, J., Baker, D. J., & Beck, J. E. (2006). Adapting to When Students Game an Intelligent Tutoring System. In M. Ikeda, K. D. Ashley, & T.-W. Chan (Eds.), Intelligent Tutoring Systems (Vol. 4053, pp. 392–401). Springer Berlin Heidelberg. https://doi.org/10.1007/11774303_39

Baker, T., & Smith, L. (2019). Educ-AI-tion Rebooted? Exploring the future of artificial intelligence in schools and colleges (p. 56).

Balan, P., & Metcalfe, M. (2012). Identifying teaching methods that engage entrepreneurship students. Education + Training, 54(5), 368–384. https://doi.org/10.1108/00400911211244678

Balki, I., Amirabadi, A., Levman, J., Martel, A. L., Emersic, Z., Meden, B., Garcia-Pedrero, A., Ramirez, S. C., Kong, D., & Moody, A. R. (2019). Sample-size determination methodologies for machine learning in medical imaging research: A systematic review. Canadian Association of Radiologists Journal, 70(4), 344–353.

Bandera, C., Collins, R., & Passerini, K. (2018). Risky business: Experiential learning, information and communications technology, and risk-taking attitudes in entrepreneurship education. The International Journal of Management Education, 16(2), 224–238.

Bandera, C., Eminet, A., Passerini, K., & Pon, K. (2018). Using Mind Maps to Distinguish Cultural Norms between French and United States Entrepreneurship Students: JOURNAL OF SMALL BUSINESS MANAGEMENT. Journal of Small Business Management, 56, 177–196. https://doi.org/10.1111/jsbm.12398

Banfield, R., Lombardo, C. T., & Wax, T. (2015). Design sprint: A practical guidebook for building great digital products. O'Reilly Media, Inc.

Barba-Sánchez, V., & Atienza-Sahuquillo, C. (2018). Entrepreneurial intention among engineering students: The role of entrepreneurship education. European Research on Management and Business Economics, 24(1), 53–61.

Barczyk, C. C., & Duncan, D. G. (2012). Social Networking Media: An Approach for the Teaching of International Business. Journal of Teaching in International Business, 23(2), 98–122. https://doi.org/10.1080/08975930.2012.718703

Barkham, R. J. (1994). Entrepreneurial characteristics and the size of the new firm: A model and an econometric test. Small Business Economics, 6(2), 117–125. https://doi.org/10.1007/BF01065184

Barnowska, B., & Kozaryn, M. (2018). Benefits from the implementation of project tasks with the use of virtual team. Management, 22(2), 204–216. https://doi.org/10.2478/manment-2018-0032

Baron, R. A. (2006). Opportunity Recognition as Pattern Recognition: How Entrepreneurs "Connect the Dots" to Identify New Business Opportunities. Academy of Management Perspectives, 20(1), 104–119. https://doi.org/10.5465/amp.2006.19873412

Barringer, B. R., Jones, F. F., & Neubaum, D. O. (2005). A quantitative content analysis of the characteristics of rapid-growth firms and their founders. Journal of Business Venturing, 20(5), 663–687. https://doi.org/10.1016/j.jbusvent.2004.03.004

Baruch, Y., & Lin, C.-P. (2012). All for one, one for all: Coopetition and virtual team performance. Technological Forecasting and Social Change, 79(6), 1155–1168. https://doi.org/10.1016/j.techfore.2012.01.008

Basly, S., & Hammouda, A. (2020). Family businesses and digital entrepreneurship adoption: A conceptual model. The Journal of Entrepreneurship, 29(2), 326–364.

Baturay, M. H. (2015). An Overview of the World of MOOCs. Procedia - Social and Behavioral Sciences, 174, 427–433. https://doi.org/10.1016/j.sbspro.2015.01.685

Beddoes, K., & Panther, G. (2018). Gender and teamwork: An analysis of professors' perspectives and practices. European Journal of Engineering Education, 43(3), 330–343.

Behl, A., Jayawardena, N., Pereira, V., Islam, N., Del Giudice, M., & Choudrie, J. (2022). Gamification and e-learning for young learners: A systematic literature review, bibliometric analysis, and future research agenda. Technological Forecasting and Social Change, 176, 121445.

Belitski, M., & Heron, K. (2017). Expanding entrepreneurship education ecosystems. Journal of Management Development.

Bell, B. S., & Kozlowski, S. W. J. (2002). A Typology of Virtual Teams: Implications for Effective Leadership. Group & Organization Management, 27(1), 14–49. https://doi.org/10.1177/1059601102027001003

Bell, R. (2020). Adapting to constructivist approaches to entrepreneurship education in the Chinese classroom. Studies in Higher Education, 45(8), 1694–1710.

Bell, R., & Bell, H. (2020). Applying educational theory to develop a framework to support the delivery of experiential entrepreneurship education. Journal of Small Business and Enterprise Development, 27(6), 987–1004. https://doi.org/10.1108/JSBED-01-2020-0012

Bellotti, F., Berta, R., De Gloria, A., Lavagnino, E., Antonaci, A., Dagnino, F., Ott, M., Romero, M., Usart, M., & Mayer, I. S. (2014). Serious games and the development of an entrepreneurial mindset in higher education engineering students. Entertainment Computing, 5(4), 357–366. https://doi.org/10.1016/j.entcom.2014.07.003

Bellotti, F., Berta, R., De Gloria, A., Lavagnino, E., Dagnino, F., Ott, M., Romero, M., Usart, M., & Mayer, I. S. (2012). Designing a course for stimulating entrepreneurship in higher education through serious games. Procedia Computer Science, 15, 174–186. https://doi.org/10.1016/j.procs.2012.10.069

Berglund, H., Bousfiha, M., & Mansoori, Y. (2020). Opportunities as artifacts and entrepreneurship as design. Academy of Management Review, 45(4), 825–846.

Bischoff, K., Volkmann, C. K., & Audretsch, D. B. (2018). Stakeholder collaboration in entrepreneurship education: An analysis of the entrepreneurial ecosystems of European higher educational institutions. The Journal of Technology Transfer, 43(1), 20–46.

Blaschke, L. M. (2014). Using social media to engage and develop the online learner in self-determined learning. Research in Learning Technology, 22. https://doi.org/10.3402/rlt.v22.21635

Blenker, P., Trolle Elmholdt, S., Hedeboe Frederiksen, S., Korsgaard, S., & Wagner, K. (2014). Methods in entrepreneurship education research: A review and integrative framework. Education + Training, 56(8/9), 697–715. https://doi.org/10.1108/ET-06-2014-0066

Bohlayer, C., & Gielnik, M. M. (2023). (S) training experiences: Toward understanding decreases in entrepreneurial self-efficacy during action-oriented entrepreneurship training. Journal of Business Venturing, 38(1), 106259.

Boldureanu, G., Ionescu, A. M., Bercu, A.-M., Bedrule-Grigoruță, M. V., & Boldureanu, D. (2020). Entrepreneurship education through successful entrepreneurial models in higher education institutions. Sustainability, 12(3), 1267.

Bond, M., Zawacki-Richter, O., & Nichols, M. (2019). Revisiting five decades of educational technology research: A content and authorship analysis of the British Journal of Educational Technology. British Journal of Educational Technology, 50(1), 12–63.

Bonk, C. J. & Graham, C. R. (2004). Blended learning systems: Definition, current trends, and future directions. Guangxue Jishu/Optical Technique, 30(6), 717.

Booker, K. C. (2007). Perceptions of classroom belongingness among African American college students. College Student Journal, 41(1).

Borras-Gene, O., Martiñez-nunez, M., & Fidalgo-Blanco, Á. (2016). New Challenges for the motivation and learning in engineering education using gamification in MOOC. International Journal of Engineering Education, 32(1), 501–512.

Bosnjak, M., Ajzen, I., & Schmidt, P. (2020). The theory of planned behavior: Selected recent advances and applications. Europe's Journal of Psychology, 16(3), 352.

Botha, M., Pohl, M., & Mubita, L. (2021). Modelling the relationship between prior entrepreneurial exposure, entrepreneurship education and entrepreneurial action using neural networks. Development Southern Africa, 38(2), 264–281.

Boyles, T. (2011). Small business and Web 2.0: Hope or hype? The Entrepreneurial Executive, 16, 81.

Bozkurt, A. (2020). Educational technology research patterns in the realm of the digital knowledge age. Journal of Interactive Media in Education, 2020(1).

Bozkurt, A., Karadeniz, A., Baneres, D., Guerrero-Roldán, A. E., & Rodríguez, M. E. (2021). Artificial intelligence and reflections from educational landscape: A review of AI studies in half a century. Sustainability, 13(2), 800.

Breuer, C., Hüffmeier, J., & Hertel, G. (2016). Does trust matter more in virtual teams? A meta-analysis of trust and team effectiveness considering virtuality and documentation as moderators. Journal of Applied Psychology, 101, 1151–1177. https://doi.org/10.1037/apl0000113

Brouwer, M. T. (2002). Weber, Schumpeter and Knight on entrepreneurship and economic development. Journal of Evolutionary Economics, 12(1), 83–105.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. The Journal of the Learning Sciences, 2(2), 141–178.

Brown, G., Crossley, C., & Robinson, S. L. (2014). Psychological ownership, territorial behavior, and being perceived as a team contributor: The critical role of trust in the work environment. Personnel Psychology, 67(2), 463–485.

Brüne, N., & Lutz, E. (2014). The effect of entrepreneurship education in schools on entrepreneurial outcomes: A systematic review. Management Review Quarterly, 70(2), 275–305.

Brusilovsky, P., Karagiannidis, C., & Sampson, D. (2004). Layered evaluation of adaptive learning systems. International Journal of Continuing Engineering Education and Life Long Learning, 14(4–5), 402–421.

Bublitz, E., & Noseleit, F. (2011). The skill balancing act: Determinants of and returns to balanced skills. Jena Economic Research Papers.

Burstein, J. (2009). Opportunities for natural language processing research in education. International Conference on Intelligent Text Processing and Computational Linguistics, 6–27.

Burt, R. S., & Burzynska, K. (2017). Chinese Entrepreneurs, Social Networks, and Guanxi. Management and Organization Review, 13(2), 221–260. https://doi.org/10.1017/mor.2017.6

Buzady, Z., & Almeida, F. (2019). FLIGBY-A serious game tool to enhance motivation and competencies in entrepreneurship. Informatics, 6(3). https://doi.org/10.3390/informatics6030027

Bylund, P. L., & McCaffrey, M. (2017). A theory of entrepreneurship and institutional uncertainty. Journal of Business Venturing, 32(5), 461–475.

Byrne, J., Fayolle, A., & Toutain, O. (2014). Entrepreneurship education: What we know and what we need to know. In Handbook of research on small business and entrepreneurship (pp. 261–288). Edward Elgar Publishing.

Calvo, S., Morales, A., & Wade, J. (2019). The use of MOOCs in social enterprise education: An evaluation of a North–South collaborative FutureLearn program. Journal of Small Business & Entrepreneurship, 31(3), 201–223. https://doi.org/10.1080/08276331.2018.1453241

Camacho, M. (2016). David Kelley: From design to design thinking at Stanford and IDEO. She Ji: The Journal of Design, Economics, and Innovation, 2(1), 88–101.

Camargo, C. P., Tempski, P. Z., Busnardo, F. F., Martins, M. de A., & Gemperli, R. (2020). Online learning and COVID-19: A meta-synthesis analysis. Clinics, 75.

Cannon-Bowers, J. A., & Salas, E. (2001). Reflections on shared cognition. Journal of Organizational Behavior, 22(2), 195–202. https://doi.org/10.1002/job.82

Carlson, J. R., Carlson, D. S., Hunter, E. M., Vaughn, R. L., & George, J. F. (2013). Virtual Team Effectiveness: Investigating the Moderating Role of Experience with Computer-Mediated Communication on the Impact of Team Cohesion and Openness. Journal of Organizational and End User Computing, 25(2), 1–18. https://doi.org/10.4018/joeuc.2013040101

Carolan, C., Davies, C. L., Crookes, P., McGhee, S., & Roxburgh, M. (2020). COVID 19: Disruptive impacts and transformative opportunities in undergraduate nurse education. Nurse Education in Practice, 46, 102807.

Carree, M. A., & Thurik, A. R. (2010). The impact of entrepreneurship on economic growth. In Handbook of entrepreneurship research (pp. 557–594). Springer.

Caserman, P., Hoffmann, K., Müller, P., Schaub, M., Straßburg, K., Wiemeyer, J., Bruder, R., & Göbel, S. (2020). Quality criteria for serious games: Serious part, game part, and balance. JMIR Serious Games, 8(3), e19037.

Casson, M., & Casson, C. (2014). The history of entrepreneurship: Medieval origins of a modern phenomenon. Business History, 56(8), 1223–1242.

Castro-Schez, J. J., Glez-Morcillo, C., Albusac, J., & Vallejo, D. (2021). An intelligent tutoring system for supporting active learning: A case study on predictive parsing learning. Information Sciences, 544, 446–468.

Chang, J., & Rieple, A. (2013). Assessing students' entrepreneurial skills development in live projects. Journal of Small Business and Enterprise Development.

Chang, W. L. (2017). Online training for business plan writing through the World Café method: The roles of leadership and trust. Universal Access in the Information Society, 16(2), 313–324. https://doi.org/10.1007/s10209-016-0459-y

Chang, W. L., & Lee, C. Y. (2013). Trust as a learning facilitator that affects students' learning performance in the Facebook community: An investigation in a business planning writing course. Computers and Education, 62, 320–327. https://doi.org/10.1016/j.compedu.2012.11.007

Chassignol, M., Khoroshavin, A., Klimova, A., & Bilyatdinova, A. (2018). Artificial Intelligence trends in education: A narrative overview. Procedia Computer Science, 136, 16–24.

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. Ieee Access, 8, 75264–75278.

Chen, L., Ifenthaler, D., & Yau, J. Y.-K. (2021). Online and blended entrepreneurship education: A systematic review of applied educational technologies. Entrepreneurship Education, 4(2), 191–232.

Chen, X., Zou, D., Cheng, G., & Xie, H. (2020). Detecting latent topics and trends in educational technologies over four decades using structural topic modeling: A retrospective of all volumes of Computers & Education. Computers & Education, 151, 103855.

Chen, X., Zou, D., Xie, H., Cheng, G., & Liu, C. (2022). Two Decades of Artificial Intelligence in Education. Educational Technology & Society, 25(1), 28–47.

Cheung, A. C., & Slavin, R. E. (2013). The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis. Educational Research Review, 9, 88–113.

Chiu, W.-K. (2021). Pedagogy of Emerging Technologies in Chemical Education during the Era of Digitalization and Artificial Intelligence: A Systematic Review. Education Sciences, 11(11), 709.

Chumg, H.-F., & Huang, C.-J. (2021). Investigating the Relationships Between Cultural Embeddedness, Happiness, and Knowledge Management Practices in an Inter-Organizational Virtual Team. Frontiers in Psychology, 11, 512288. https://doi.org/10.3389/fpsyg.2020.512288

Chung, E., Noor, N. M., & Mathew, V. N. (2020). Are you ready? An assessment of online learning readiness among university students. International Journal of Academic Research in Progressive Education and Development, 9(1), 301–317.

Ciampi, F., Demi, S., Magrini, A., Marzi, G., & Papa, A. (2021). Exploring the impact of big data analytics capabilities on business model innovation: The mediating role of entrepreneurial orientation. JOURNAL OF BUSINESS RESEARCH, 123, 1–13. https://doi.org/10.1016/j.jbusres.2020.09.023

Cirulli, F., Cirulli, F., Elia, G., Lorenzo, G., & Margherita, A. (2016). Knowledge Management & E-Learning application in the technology entrepreneurship field Recommended citation: Application in the technology entrepreneurship field. 8(1), 109–123.

Cirulli, F., Elia, G., Lorenzo, G., Margherita, A., & Solazzo, G. (2016). The use of MOOCs to support personalized learning: An application in the technology entrepreneurship field. Knowledge Management & E-Learning: An International Journal, 8(1), 109–123.

Clancey, W. J., & Hoffman, R. R. (2021). Methods and standards for research on explainable artificial intelligence: Lessons from intelligent tutoring systems. Applied AI Letters, e53.

Clarizia, F., Colace, F., Lombardi, M., Pascale, F., & Santaniello, D. (2018). Chatbot: An education support system for student. International Symposium on Cyberspace Safety and Security, 291–302.

Clark, D. N., & Gibb, J. L. (2006). Virtual team learning: An introductory study team exercise. Journal of Management Education, 30(6), 765–787.

Clough, D. R., Fang, T. P., Vissa, B., & Wu, A. (2019). Turning lead into gold: How do entrepreneurs mobilize resources to exploit opportunities? Academy of Management Annals, 13(1), 240–271.

Cobb, S. C. (2009). Social presence and online learning: A current view from a research perspective. Journal of Interactive Online Learning, 8(3).

Cohen, D., Hsu, D. K., & Shinnar, R. S. (2021). Identifying innovative opportunities in the entrepreneurship classroom: A new approach and empirical test. Small Business Economics, 57(4), 1931–1955.

Cohen, S. L., Bingham, C. B., & Hallen, B. L. (2019). The Role of Accelerator Designs in Mitigating Bounded Rationality in New Ventures. ADMINISTRATIVE SCIENCE QUARTERLY, 64(4), 810–854. https://doi.org/10.1177/0001839218782131

Colombelli, A., Panelli, A., & Serraino, F. (2022). A Learning-by-Doing Approach to Entrepreneurship Education: Evidence from a Short Intensive Online International Program. Administrative Sciences, 12(1), 16.

Colquhoun, H. L., Levac, D., O'Brien, K. K., Straus, S., Tricco, A. C., Perrier, L., Kastner, M., & Moher, D. (2014). Scoping reviews: Time for clarity in definition, methods, and reporting. Journal of Clinical Epidemiology, 67(12), 1291–1294. https://doi.org/10.1016/j.jclinepi.2014.03.013

Constanţa-Nicoleta, B., Radu Ioan, M., Maria-Iuliana, D., Augustin, P., Narcisa Georgeta, C. (2015). Simulation-Based E-Learning Framework for Entrepreneurship Education and Training. Amfiteatru Economic Journal, 17(38), 10–24.

Cooper, S., Bottomley, C., & Gordon, J. (2004). Stepping out of the classroom and up the ladder of learning: An experiential learning approach to entrepreneurship education. Industry and Higher Education, 18(1), 11–22.

Cope, B., Kalantzis, M., & Searsmith, D. (2021). Artificial intelligence for education: Knowledge and its assessment in AI-enabled learning ecologies. Educational Philosophy and Theory, 53(12), 1229–1245.

Cope, J. (2003). Entrepreneurial learning and critical reflection: Discontinuous events as triggers for 'higher-level'learning. Management Learning, 34(4), 429–450.

Cope, J. (2011). Entrepreneurial learning from failure: An interpretative phenomenological analysis. Journal of Business Venturing, 26(6), 604–623.

Corriveau, A.-M. (2020). Developing authentic leadership as a starting point to responsible management: A Canadian university case study. The International Journal of Management Education, 18(1), 100364.

Cox, A. M. (2021). Exploring the impact of Artificial Intelligence and robots on higher education through literature-based design fictions. International Journal of Educational Technology in Higher Education, 18(1), 1–19.

Crawford, E. R., & LePine, J. A. (2013). A Configural Theory of Team Processes: Accounting for the Structure of Taskwork and Teamwork. Academy of Management Review, 38(1), 32–48. https://doi.org/10.5465/amr.2011.0206

Crescenzi, R., Rodriguez-Pose, A., & Storper, M. (2007). The territorial dynamics of innovation: A Europe–United States comparative analysis. Journal of Economic Geography, 7(6), 673–709.

Criaco, G., Minola, T., Migliorini, P., & Serarols-Tarrés, C. (2014a). "To have and have not": Founders' human capital and university start-up survival. The Journal of Technology Transfer, 39(4), 567–593.

Criaco, G., Minola, T., Migliorini, P., & Serarols-Tarrés, C. (2014b). "To have and have not": Founders' human capital and university start-up survival. The Journal of Technology Transfer, 39(4), 567–593.

Crosina, E. (2018). On becoming an entrepreneur: Unpacking entrepreneurial identity. In A research agenda for women and entrepreneurship (pp. 93–113). Edward Elgar Publishing.

Cui, J. (2021). The impact of entrepreneurship curriculum with teaching models on sustainable development of entrepreneurial mindset among higher education students in China: The moderating role of the entrepreneurial climate at the institution. Sustainability, 13(14), 7950.

Czyzewska, M., & Mroczek, T. (2020). Data Mining in Entrepreneurial Competencies Diagnosis. Education Sciences, 10(8), 196. https://doi.org/10.3390/educsci10080196

Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. The Internet and Higher Education, 15(1), 3–8. https://doi.org/10.1016/j.iheduc.2011.06.002

Dabić, M., Ortiz-De-Urbina-Criado, M., & Romero-Martínez, A. M. (2011). Human resource management in entrepreneurial firms: A literature review. International Journal of Manpower, 32(1), 14–33.

Davidovitch, N., & Eckhaus, E. (2020). The Relationship between Students' Research Motivation, Capacity for Independent Work, and Research Outputs: Defining the Good Advisee Using Natural Language Processing. Journal of Education and Learning, 9(5), 38–44.

Davidsson, P. (2021). Ditching discovery-creation for unified venture creation research. Entrepreneurship Theory and Practice, 10422587211030870.

Davidsson, P., & Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. Journal of Business Venturing, 18(3), 301–331. https://doi.org/10.1016/S0883-9026(02)00097-6

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 319–340.

De Dreu, C. K. W., & Weingart, L. R. (2003). Task versus relationship conflict, team performance, and team member satisfaction: A meta-analysis. Journal of Applied Psychology, 88(4), 741–749. https://doi.org/10.1037/0021-9010.88.4.741

Demirbilek, M., & Talan, T. (2018). The effect of social media multitasking on classroom performance. Active Learning in Higher Education, 19(2), 117–129.

Demirkan, H., & Spohrer, J. (2015). T-Shaped Innovators: Identifying the Right Talent to Support Service Innovation. Research-Technology Management, 58(5), 12–15. https://doi.org/10.5437/08956308X5805007

Deng, B., & Wu, J. (2021). The Cultivation of Innovation and Entrepreneurship Skills and Teaching Strategies for College Students from the Perspective of Big Data. Arabian Journal for Science and Engineering, 1–14.

Denny, J. C., Bastarache, L., Sastre, E. A., & Spickard III, A. (2009). Tracking medical students' clinical experiences using natural language processing. Journal of Biomedical Informatics, 42(5), 781–789.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining" gamification". Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, 9–15.

DeTienne, D. R., & Chandler, G. N. (2004). Opportunity identification and its role in the entrepreneurial classroom: A pedagogical approach and empirical test. Academy of Management Learning & Education, 3(3), 242–257.

Dew, N., Sarasathy, S., Read, S., & Wiltbank, R. (2009). Affordable loss: Behavioral economic aspects of the plunge decision. Strategic Entrepreneurship Journal, 3(2), 105–126.

Divall, M. V., & Kirwin, J. L. (2012). Using facebook to facilitate course-related discussion between students and faculty members. American Journal of Pharmaceutical Education, 76(2), 1–5. https://doi.org/10.5688/ajpe76232

Donnellon, A., Ollila, S., & Middleton, K. W. (2014). Constructing entrepreneurial identity in entrepreneurship education. The International Journal of Management Education, 12(3), 490–499.

Dumford, A. D., & Miller, A. L. (2018). Online learning in higher education: Exploring advantages and disadvantages for engagement. Journal of Computing in Higher Education, 30(3), 452–465.

Dumpit, D. Z., & Fernandez, C. J. (2017). Analysis of the use of social media in Higher Education Institutions (HEIs) using the Technology Acceptance Model. International Journal of Educational Technology in Higher Education, 14(1), 1–16.

Duval-Couetil, N. (2013). Assessing the impact of entrepreneurship education programs: Challenges and approaches. Journal of Small Business Management, 51(3), 394–409.

Duval-Couetil, N., & Shartrand, A. (2016). The Role of Entrepreneurship Program Models and -Experiential Activities on Engineering Student Outcomes. 27.

Eck, R. V. (2006). Digital Game-Based Learning: It's Not Just the Digital Natives Who Are Restless…. 17.

Eckhardt, J. T., & Shane, S. A. (2003). Opportunities and entrepreneurship. Journal of Management, 29(3), 333–349.

Elhajjar, S., Karam, S., & Borna, S. (2021). Artificial intelligence in marketing education programs. Marketing Education Review, 31(1), 2–13.

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.

Elyousfi, F., Anand, A., & Dalmasso, A. (2021). Impact of e-leadership and team dynamics on virtual team performance in a public organization. International Journal of Public Sector Management, 34(5), 508–528. https://doi.org/10.1108/IJPSM-08-2020-0218

Entin, E. E., & Serfaty, D. (1999). Adaptive Team Coordination. Human Factors: The Journal of the Human Factors and Ergonomics Society, 41(2), 312–325. https://doi.org/10.1518/001872099779591196

Erdisna, E., Ridwan, M., & Syahputra, H. (2022). Developing Digital Entrepreneurship Learning Model: 4-D Competencies-Based for Millennial Generation in Higher Education. Utamax: Journal of Ultimate Research and Trends in Education, 4(2), 84–100.

Erümit, A. K., & Çetin, İ. (2020). Design framework of adaptive intelligent tutoring systems. Education and Information Technologies, 25(5), 4477–4500.

Escamilla-Fajardo, P., Alguacil, M., & López-Carril, S. (2021). Incorporating TikTok in higher education: Pedagogical perspectives from a corporal expression sport sciences course. Journal of Hospitality, Leisure, Sport & Tourism Education, 28, 100302.

Etzkowitz, H. (2014). The entrepreneurial university wave: From ivory tower to global economic engine. Industry and Higher Education, 28(4), 223–232.
Farber, V. A., Prialé, M. A., & Fuchs, R. M. (2015). An entrepreneurial learning exercise as a pedagogical tool for teaching CSR: A Peruvian study. Industry and Higher Education, 29(5), 345–360.
Fathema, N., Shannon, D., & Ross, M. (2015). Expanding the Technology Acceptance Model (TAM) to examine faculty use of Learning Management Systems (LMSs) in higher education institutions. Journal of Online Learning & Teaching, 11(2).
Fayolle, A. (2008). ENTREPRENEURSHIP EDUCATION AT A CROSSROADS: TOWARDS A MORE MATURE TEACHING FIELD. Journal of Enterprising Culture, 16(04), 325–337. https://doi.org/10.1142/S0218495808000211
Fayolle, A. (2013). Personal views on the future of entrepreneurship education. A Research Agenda for Entrepreneurship Education, 25(May), 127–138. https://doi.org/10.4337/9781786432919.00013
Fayolle, A. (2018). Personal views on the future of entrepreneurship education. In A research agenda for entrepreneurship education. Edward Elgar Publishing.
Fayolle, A., & Gailly, B. (2008). From craft to science: Teaching models and learning processes in entrepreneurship education. Journal of European Industrial Training.
Fayolle, A., & Gailly, B. (2015). The impact of entrepreneurship education on entrepreneurial attitudes and intention: Hysteresis and persistence. Journal of Small Business Management, 53(1), 75–93.
Fayolle, A., Gailly, B., & Lassas-Clerc, N. (2006). Assessing the impact of entrepreneurship education programmes: A new methodology. Journal of European Industrial Training.
Fejes, A., Nylund, M., & Wallin, J. (2019). How do teachers interpret and transform entrepreneurship education? Journal of Curriculum Studies, 51(4), 554–566.
Felin, T., Gambardella, A., Stern, S., & Zenger, T. (2019). Lean startup and the business model: Experimentation revisited. Forthcoming in Long Range Planning (Open Access).
Fellnhofer, K. (2015). Changing entrepreneurial intention and behaviour: A digital game-based learning environment dedicated to entrepreneurship education. J. for International Business and Entrepreneurship Development, 8(4), 378. https://doi.org/10.1504/jibed.2015.072938
Fellnhofer, K. (2019). Toward a taxonomy of entrepreneurship education research literature: A bibliometric mapping and visualization. Educational Research Review, 27, 28–55.
Feng, S., & Law, N. (2021). Mapping Artificial Intelligence in Education Research: A Network-based Keyword Analysis. International Journal of Artificial Intelligence in Education, 31(2), 277–303.
Ferguson, C., Van den Broek, E. L., & Van Oostendorp, H. (2020). On the role of interaction mode and story structure in virtual reality serious games. Computers & Education, 143, 103671.
Ferguson, R. (2012). Learning analytics: Drivers, developments and challenges. International Journal of Technology Enhanced Learning, 4(5–6), 304–317.
Ferreira, J. J., Raposo, M. L., Rodrigues, R. G., Dinis, A., & Do Paco, A. (2012). A model of entrepreneurial intention: An application of the psychological and behavioral approaches. Journal of Small Business and Enterprise Development, 19(3), 424–440.
Fiet, J. O. (2001). The theoretical side of teaching entrepreneurship. Journal of Business Venturing, 16(1), 1–24. https://doi.org/10.1016/S0883-9026(99)00041-5
Fischer, C., Pardos, Z. A., Baker, R. S., Williams, J. J., Smyth, P., Yu, R., Slater, S., Baker, R., & Warschauer, M. (2020). Mining big data in education: Affordances and challenges. Review of Research in Education, 44(1), 130–160.
Forster-Holt, N. (2021). Stimulation versus simulation: The student side hustle as a learning innovation. Entrepreneurship Education and Pedagogy, 4(4), 808–829.

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.

Fox, J., Pittaway, L., Uzuegbunam, I. (2018). Simulations in Entrepreneurship Education: Serious Games and Learning Through Play.pdf (pp. 61–89).

Frederick, H. (2007). Blended learning in entrepreneurship education in the Asia-Pacific: A grounded theory approach to entrepreneurship pedagogy. Deakin Research Online, 1–16.

Freire, M., Del Blanco, Á., & Fernańdez-Manjón, B. (2014). Serious games as edX MOOC activities. IEEE Global Engineering Education Conference, EDUCON, April, 867–871. https://doi.org/10.1109/EDUCON.2014.6826198

Frese, M., & Gielnik, M. M. (2014). The psychology of entrepreneurship. Annual Review of Organizational Psychology and Organizational Behavior, 1(1), 413–438.

Fryer, L. K., Nakao, K., & Thompson, A. (2019). Chatbot learning partners: Connecting learning experiences, interest and competence. Computers in Human Behavior, 93, 279–289. https://doi.org/10.1016/j.chb.2018.12.023

Fuentes Fuentes, M. del M., Ruiz Arroyo, M., Bojica, A. M., & Fernández Pérez, V. (2010). Prior knowledge and social networks in the exploitation of entrepreneurial opportunities. International Entrepreneurship and Management Journal, 6, 481–501.

Gaglio, C. M., & Katz, J. A. (2001). The psychological basis of opportunity identification: Entrepreneurial alertness. Small Business Economics, 16, 95–111.

Garcia-Lorenzo, L., Donnelly, P., Sell-Trujillo, L., & Imas, J. M. (2018). Liminal entrepreneuring: The creative practices of nascent necessity entrepreneurs. Organization Studies, 39(2–3), 373–395.

García-Morales, V. J., Garrido-Moreno, A., & Martín-Rojas, R. (2021). The transformation of higher education after the COVID disruption: Emerging challenges in an online learning scenario. Frontiers in Psychology, 12, 616059.

García-Morales, V. J., Martín-Rojas, R., & Garde-Sánchez, R. (2020). How to Encourage Social Entrepreneurship Action? Using Web 2.0 Technologies in Higher Education Institutions. Journal of Business Ethics, 161(2), 329–350. https://doi.org/10.1007/s10551-019-04216-6

Garrison, D. R., Anderson, T., & Archer, W. (2003). A theory of critical inquiry in online distance education. Handbook of Distance Education, 1(4), 113–127.

Garrison, D. R., & Arbaugh, J. B. (2007). Researching the community of inquiry framework: Review, issues, and future directions. The Internet and Higher Education, 10(3), 157–172.

Gartner, W. B. (1988). “Who is an entrepreneur?” is the wrong question. American Journal of Small Business, 12(4), 11–32.

Gartner, W. B., & Shaver, K. G. (2012). Nascent entrepreneurship panel studies: Progress and challenges. Small Business Economics, 39(3), 659–665.

Gartner, W., & Liao, J. (2012). The effects of perceptions of risk, environmental uncertainty, and growth aspirations on new venture creation success. Small Business Economics, 39, 703–712.

Gašević, D., Dawson, S., & Siemens, G. (2015). Let’s not forget: Learning analytics are about learning. TechTrends, 59(1), 64–71.

Georgescu, M.-A., & Herman, E. (2020). The impact of the family background on students’ entrepreneurial intentions: An empirical analysis. Sustainability, 12(11), 4775.

Ghezzi, A. (2019). Digital startups and the adoption and implementation of Lean Startup Approaches: Effectuation, Bricolage and Opportunity Creation in practice. Technological Forecasting and Social Change, 146, 945–960.

Gibb, A. (2002). In pursuit of a new “enterprise” and “entrepreneurship” paradigm for learning: Creative destruction, new values, new ways of doing things and new combinations of knowledge. International Journal of Management Reviews, 4(3), 233–269. https://doi.org/10.1111/1468-2370.00086

Gibb, A. (2005). The future of entrepreneurship education–Determining the basis for coherent policy and practice. The Dynamics of Learning Entrepreneurship in a Cross-Cultural University Context, 2(2005), 44–67.

Gibb, A. A. (1996). Entrepreneurship and small business management: Can we afford to neglect them in the twenty-first century business school? British Journal of Management, 7(4), 309–321.

Gielnik, M. M., Bledow, R., & Stark, M. S. (2020). A dynamic account of self-efficacy in entrepreneurship. Journal of Applied Psychology, 105(5), 487.

Gielnik, M. M., Frese, M., Kahara-Kawuki, A., Wasswa Katono, I., Kyejjusa, S., Ngoma, M., Munene, J., Namatovu-Dawa, R., Nansubuga, F., & Orobia, L. (2015). Action and action-regulation in entrepreneurship: Evaluating a student training for promoting entrepreneurship. Academy of Management Learning & Education, 14(1), 69–94.

Gielnik, M. M., Krämer, A.-C., Kappel, B., & Frese, M. (2014). Antecedents of business opportunity identification and innovation: Investigating the interplay of information processing and information acquisition. Applied Psychology, 63(2), 344–381.

Gieure, C., Benavides-Espinosa, M. del M., & Roig-Dobón, S. (2019). Entrepreneurial intentions in an international university environment. International Journal of Entrepreneurial Behavior & Research, 25(8), 1605–1620.

Gifford, E. (2021). Theory-driven methods for practical entrepreneurship: Hypothesis testing in entrepreneurship education. Industry and Higher Education, 35(4), 497–504.

Gikandi, J. W., Morrow, D., & Davis, N. E. (2011). Online formative assessment in higher education: A review of the literature. Computers & Education, 57(4), 2333–2351.

Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. The Internet and Higher Education, 19, 18–26. https://doi.org/10.1016/j.iheduc.2013.06.002

Gimmon, E., & Levie, J. (2010). Founder's human capital, external investment, and the survival of new high-technology ventures. Research Policy, 39(9), 1214–1226.

Girard, C., Ecalle, J., & Magnan, A. (2013). Serious games as new educational tools: How effective are they? A meta-analysis of recent studies. Journal of Computer Assisted Learning, 29(3), 207–219.

Goldstein, A., & Gafni, R. (2019). Learning Entrepreneurship through Virtual Multicultural Teamwork. Issues in Informing Science and Information Technology, 16, 277–305. https://doi.org/10.28945/4332

Gonda, D. E., Luo, J., Wong, Y.-L., & Lei, C.-U. (2018). Evaluation of developing educational chatbots based on the seven principles for good teaching. 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE), 446–453.

Gong, M., Xu, Y., & Yu, Y. (2004). An enhanced technology acceptance model for web-based learning. Journal of Information Systems Education, 15(4).

Graham, B., & Bonner, K. (2022). One size fits all? Using machine learning to study heterogeneity and dominance in the determinants of early-stage entrepreneurship. Journal of Business Research, 152, 42–59.

Granić, A., & Marangunić, N. (2019). Technology acceptance model in educational context: A systematic literature review. British Journal of Educational Technology, 50(5), 2572–2593.

Gruber, M. (2002). The entrepreneurial mindset: Strategies for continuously creating opportunity in an age of uncertainty. Schmalenbach Business Review: ZFBF, 54(4), 380.

Gruzd, A., Haythornthwaite, C., Paulin, D., Gilbert, S., & del Valle, M. E. (2018). Uses and Gratifications factors for social media use in teaching: Instructors' perspectives. New Media & Society, 20(2), 475–494. https://doi.org/10.1177/1461444816662933

Guan, C. (2020). Artificial intelligence innovation in education: A twenty-year data-driven historical analysis. International Journal of Innovation Studies, 14.

Guerrero, M., Heaton, S., & Urbano, D. (2021). Building universities' intrapreneurial capabilities in the digital era: The role and impacts of Massive Open Online Courses (MOOCs). Technovation, 99, 102139.

Guest, D., & King, Z. (2004). Power, innovation and problem-solving: The personnel managers' three steps to heaven? Journal of Management Studies, 41(3), 401–423.

Gupta, N., & Bharadwaj, S. S. (2013). Agility in business school education through richness and reach: A conceptual model. 15.

Hägg, G., & Gabrielsson, J. (2019). A systematic literature review of the evolution of pedagogy in entrepreneurial education research. International Journal of Entrepreneurial Behavior & Research.

Hahn, D., Minola, T., Bosio, G., & Cassia, L. (2020). The impact of entrepreneurship education on university students' entrepreneurial skills: A family embeddedness perspective. Small Business Economics, 55(1), 257–282.

Hahn, D., Minola, T., Van Gils, A., & Huybrechts, J. (2017). Entrepreneurial education and learning at universities: Exploring multilevel contingencies. Entrepreneurship & Regional Development, 29(9–10), 945–974.

Hair, N., Wetsch, L. R., Hull, C. E., Perotti, V., & Hung, Y.-T. C. (2012). Market orientation in digital entrepreneurship: Advantages and challenges in a Web 2.0 networked world. International Journal of Innovation and Technology Management, 9(06), 1250045.

Halberstadt, J., Timm, J.-M., Kraus, S., & Gundolf, K. (2019). Skills and knowledge management in higher education: How service learning can contribute to social entrepreneurial competence development. Journal of Knowledge Management.

Han, I., & Shin, W. S. (2016). The use of a mobile learning management system and academic achievement of online students. Computers & Education, 102, 79–89.

Handler, W. C. (1990). Succession in Family Firms: A Mutual Role Adjustment between Entrepreneur and Next-generation Family Members. Entrepreneurship Theory and Practice, 15(1), 37–52. https://doi.org/10.1177/104225879001500105

Hao, C. (2021). An Exploratory Research on Constructing a Model of Innovation and Entrepreneurship Education for College Students Based on Fuzzy Neural Network Algorithm. Security and Communication Networks, 2021.

Harms, R. (2015). Self-regulated learning, team learning and project performance in entrepreneurship education: Learning in a lean startup environment. Technological Forecasting and Social Change, 100, 21–28. https://doi.org/10.1016/j.techfore.2015.02.007

Hart, C. M., Berger, D., Jacob, B., Loeb, S., & Hill, M. (2019). Online learning, offline outcomes: Online course taking and high school student performance. Aera Open, 5(1), 2332858419832852.

Hayes, D., & Richmond, W. (2017). Using an online assessment to examine entrepreneurship student traits and to measure and improve the impact of entrepreneurship education. Journal of Entrepreneurship Education, 20(1), 88–107.

He, J., & Huang, X. (2017). Collaborative Online Teamwork: Exploring Students' Satisfaction and Attitudes with Google Hangouts as a Supplementary Communication Tool. Journal of Research on Technology in Education, 49(3–4), 149–160. https://doi.org/10.1080/15391523.2017.1327334

Hébert, R. F., & Link, A. N. (2009). A history of entrepreneurship. Routledge.

Heinonen, J., & Hytti, U. (2010). Back to basics: The role of teaching in developing the entrepreneurial university. The International Journal of Entrepreneurship and Innovation, 11(4), 283–292.

Heinonen, J., & Poikkijoki, S.-A. (2006). An entrepreneurial-directed approach to entrepreneurship education: Mission impossible? Journal of Management Development.

Henry, C., Hill, F., & Leitch, C. (2005). Entrepreneurship education and training: Can entrepreneurship be taught? Part I. Education and Training, 47(2), 98–111. https://doi.org/10.1108/00400910510586524

Hertel, C., Binder, J., & Fauchart, E. (2021). Getting more from many—A framework of community resourcefulness in new venture creation. Journal of Business Venturing, 36(3), 106094.

Hew, K. F., & Cheung, W. S. (2014). Students' and instructors' use of massive open online courses (MOOCs): Motivations and challenges. Educational Research Review, 12, 45–58.

Hien, H. T., Cuong, P.-N., Nam, L. N. H., Nhung, H. L. T. K., & Thang, L. D. (2018). Intelligent assistants in higher-education environments: The FIT-EBot, a chatbot for administrative and learning support. Proceedings of the Ninth International Symposium on Information and Communication Technology, 69–76.

Hindle, K. (2002). A Grounded Theory for Teaching Entrepreneurship Using Simulation Games. 6.

Hindle, K. (2009). The relationship between innovation and entrepreneurship: Easy definition, hard policy. Paper Delivered to the Refereed Stream of the 6th AGSE International Entrepreneurship Research Exchange, 3–6.

Hinojo-Lucena, F.-J., Aznar-Díaz, I., Cáceres-Reche, M.-P., & Romero-Rodríguez, J.-M. (2019). Artificial intelligence in higher education: A bibliometric study on its impact in the scientific literature. Education Sciences, 9(1), 51.

Ho, S.-C., & Chen, J.-L. (2023). Developing the e-commerce competency for entrepreneurship education from a gamified competition. The International Journal of Management Education, 21(1), 100737.

Hodges, J., & Mohan, S. (2019). Machine Learning in Gifted Education: A Demonstration Using Neural Networks. Gifted Child Quarterly, 63(4), 243–252. https://doi.org/10.1177/0016986219867483

Holinska, T., Komarovska, O., Melnyk, O., Pet'ko, L., Shpitsa, R., Sova, O., & Strohal, T. (2019). Cloud technologies in art entrepreneurship education. Journal of Entrepreneurship Education, 22(5), 1–6.

Holtkamp, P., Lau, I., & Pawlowski, J. M. (2015). How software development competences change in global settings-an explorative study: HOW SOFTWARE DEVELOPMENT COMPETENCES CHANGE IN GLOBAL SETTINGS. Journal of Software: Evolution and Process, 27(1), 50–72. https://doi.org/10.1002/smr.1701

Holzinger, A., Langs, G., Denk, H., Zatloukal, K., & Müller, H. (2019). Causability and explainability of artificial intelligence in medicine. Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, 9(4), e1312.

Honjo, Y. (2004). Growth of new start-up firms: Evidence from the Japanese manufacturing industry. Applied Economics, 36(4), 343–355. https://doi.org/10.1080/00036840410001674277

Hoogendoorn, B., Van der Zwan, P., & Thurik, R. (2019). Sustainable entrepreneurship: The role of perceived barriers and risk. Journal of Business Ethics, 157, 1133–1154.

Horst, S.-O., Järventie-Thesleff, R., & Perez-Latre, F. J. (2020). Entrepreneurial identity development through digital media. Journal of Media Business Studies, 17(2), 87–112.

Huang, Y., An, L., Liu, L., Zhuo, Z., & Wang, P. (2020). Exploring factors link to teachers' competencies in entrepreneurship education. Frontiers in Psychology, 11, 563381.

Huang-Saad, A. Y., Morton, C. S., & Libarkin, J. C. (2018). Entrepreneurship Assessment in Higher Education: A Research Review for Engineering Education Researchers: Entrepreneurship Assessment in Higher Education. Journal of Engineering Education, 107(2), 263–290. https://doi.org/10.1002/jee.20197

Hu\djek, I., Širec, K., & Tominc, P. (2019). Digital skills in enterprises according to the European digital entrepreneurship sub-indices: Cross-country empirical evidence. Management: Journal of Contemporary Management Issues, 24(2), 107–119.

Huntsley, J., & Brentnall, C. (2021). Generative critical conversation: A method for developing reflexivity and criticality. Journal of Small Business Management, 1–30.

Hwang, G.-J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Education. Elsevier.

Hytti, U., & O'Gorman, C. (2004). What is "enterprise education"? An analysis of the objectives and methods of enterprise education programmes in four European countries. Education + Training, 46(1), 11–23. https://doi.org/10.1108/00400910410518188

Hytti, U., Stenholm, P., Heinonen, J., & Seikkula-Leino, J. (2010). Perceived learning outcomes in entrepreneurship education: The impact of student motivation and team behaviour. Education + Training, 52(8/9), 587–606. https://doi.org/10.1108/00400911011088935

Ifenthaler, D. (2014). Toward automated computer-based visualization and assessment of team-based performance. Journal of Educational Psychology, 106(3), 651–665. https://doi.org/10.1037/a0035505

Ifenthaler, D. (2017). Are higher education institutions prepared for learning analytics? TechTrends, 61(4), 366–371.

Ifenthaler, D., Eseryel, D., & Ge, X. (2012). Assessment for Game-Based Learning. In D. Ifenthaler, D. Eseryel, & X. Ge (Eds.), Assessment in Game-Based Learning (pp. 1–8). Springer New York. https://doi.org/10.1007/978-1-4614-3546-4_1

Ifenthaler, D., Schumacher, C., & Kuzilek, J. (2022). Investigating students' use of self-assessments in higher education using learning analytics. Journal of Computer Assisted Learning.

Ifenthaler, D., & Yau, J. Y.-K. (2020). Utilising learning analytics to support study success in higher education: A systematic review. Educational Technology Research and Development, 68(4), 1961–1990. https://doi.org/10.1007/s11423-020-09788-z

Igwe, P. A., Okolie, U. C., & Nwokoro, C. V. (2021). Towards a responsible entrepreneurship education and the future of the workforce. The International Journal of Management Education, 19(1), 100300. https://doi.org/10.1016/j.ijme.2019.05.001

Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in Organizations: From Input-Process-Output Models to IMOI Models. Annual Review of Psychology, 56(1), 517–543. https://doi.org/10.1146/annurev.psych.56.091103.070250

Ismailov, M., & Laurier, J. (2021). We are in "the breakout room." Now what? An e-portfolio study of virtual team processes involving undergraduate online learners. E-Learning and Digital Media, 204275302110397. https://doi.org/10.1177/20427530211039710

Išoraitė, M., & Gulevičiūtė, G. (2021). A study of online entrepreneurship education under conditions of a pandemic. Entrepreneurship and Sustainability Issues, 8(3), 179.

Ivanytska, N., Tymoshchuk, N., Dovhan, L., Osaulchyk, O., & Havryliuk, N. (2021). EFFECTIVENESS OF DIGITAL RESOURCES IN THE LEARNING MANAGEMENT SYSTEM WITHIN ONLINE EDUCATION OF FUTURE ENTREPRENEURS. 24(4), 9.

Iwu, C. G., Opute, P. A., Nchu, R., Eresia-Eke, C., Tengeh, R. K., Jaiyeoba, O., & Aliyu, O. A. (2021). Entrepreneurship education, curriculum and lecturer-competency as antecedents of student entrepreneurial intention. The International Journal of Management Education, 19(1), 100295.

Jaggars, S. S., & Xu, D. (2016). How do online course design features influence student performance? Computers & Education, 95, 270–284.

Januszewski, A. & Molenda, M. (2013). Educational Technology: A definition with commentary. In Journal of Chemical Information and Modeling (Vol. 53, Issue 9). https://doi.org/10.1017/CBO9781107415324.004

Javed, U., Shaukat, K., Hameed, I. A., Iqbal, F., Alam, T. M., & Luo, S. (2021). A review of content-based and context-based recommendation systems. International Journal of Emerging Technologies in Learning (IJET), 16(3), 274–306.

Jena, R. K. (2018). Predicting students' learning style using learning analytics: A case study of business management students from India. Behaviour & Information Technology, 37(10–11), 978–992.

Jena, R. K. (2020). Measuring the impact of business management Student's attitude towards entrepreneurship education on entrepreneurial intention: A case study. Computers in Human Behavior, 107, 106275.

Jeong, H., & Hmelo-Silver, C. E. (2016). Seven Affordances of Computer-Supported Collaborative Learning: How to Support Collaborative Learning? How Can Technologies Help? Educational Psychologist, 51(2), 247–265. https://doi.org/10.1080/00461520.2016.1158654

Jones, B., & Iredale, N. (2009). Entrepreneurship education and Web 2.0. Journal of Research in Marketing and Entrepreneurship, 11(1), 66–77. https://doi.org/10.1108/14715200911014158

Jones, C. (2010). Entrepreneurship education: Revisiting our role and its purpose. Journal of Small Business and Enterprise Development, 17(4), 500–513. https://doi.org/10.1108/14626001011088697

Jones, C. (2011). Teaching entrepreneurship to undergraduates. In Teaching Entrepreneurship to Undergraduates. Edward Elgar Publishing.

Jones, C., & English, J. (2004). A contemporary approach to entrepreneurship education. Education+ Training.

Jordan, K. (2014). Initial trends in enrolment and completion of massive open online courses. The International Review of Research in Open and Distributed Learning, 15(1). https://doi.org/10.19173/irrodl.v15i1.1651

Josien, L., Sybrowsky, J. (2013). Teaching entrepreneurship in action: Using Ebay as an enducational tool. Journal of Entrepreneurship Education, 16(January 2013), 1–11.

Julie Yazici, H. (2005). A study of collaborative learning style and team learning performance. Education+ Training, 47(3), 216–229.

Kaplan, A., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. Business Horizons, 62(1), 15–25.

Kaplan, A. M., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media. Business Horizons, 53(1), 59–68. https://doi.org/10.1016/j.bushor.2009.09.003

Kaplan, A. M., & Haenlein, M. (2016). Higher education and the digital revolution: About MOOCs, SPOCs, social media, and the Cookie Monster. Business Horizons, 59(4), 441–450. https://doi.org/10.1016/j.bushor.2016.03.008

Kaplan, S. N., Sensoy, B. A., & Strömberg, P. (2009). Should investors bet on the jockey or the horse? Evidence from the evolution of firms from early business plans to public companies. The Journal of Finance, 64(1), 75–115.

Karaa, W. B. A., Alkhammash, E., Slimani, T., & Hadjouni, M. (2021). Intelligent Recommendations of Startup Projects in Smart Cities and Smart Health Using Social Media Mining. JOURNAL OF HEALTHCARE ENGINEERING, 2021. https://doi.org/10.1155/2021/3400943

Karimi, S., Biemans, H. J., Lans, T., Aazami, M., & Mulder, M. (2016). Fostering students' competence in identifying business opportunities in entrepreneurship education. Innovations in Education and Teaching International, 53(2), 215–229.

Karimi, S., & Chizari, M. (2010). Entrepreneurship Education in Iranian Higher Education: The Current State and Challenges. 16.

Kariv, D., Cisneros, L., & Ibanescu, M. (2019). The role of entrepreneurial education and support in business growth intentions: The case of Canadian entrepreneurs. Journal of Small Business & Entrepreneurship, 31(5), 433–460. https://doi.org/10.1080/08276331.2018.1468974

Kassean, H., Vanevenhoven, J., Liguori, E., & Winkel, D. E. (2015). Entrepreneurship education: A need for reflection, real-world experience and action. International Journal of Entrepreneurial Behavior & Research, 21(5), 690–708. https://doi.org/10.1108/IJEBR-07-2014-0123

Kauppinen, A., & Choudhary, A. I. (2021). Gamification in entrepreneurship education: A concrete application of Kahoot! The International Journal of Management Education, 19(3), 100563.

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.

Keeling, R. (2006). The Bologna Process and the Lisbon Research Agenda: The European Commission's expanding role in higher education discourse. European Journal of Education, 41(2), 203–223.

Khanal, S. S., Prasad, P. W. C., Alsadoon, A., & Maag, A. (2020). A systematic review: Machine learning based recommendation systems for e-learning. Education and Information Technologies, 25(4), 2635–2664.

Kietzmann, J. H., Hermkens, K., McCarthy, I. P., & Silvestre, B. S. (2011). Social media? Get serious! Understanding the functional building blocks of social media. Business Horizons, 54(3), 241–251. https://doi.org/10.1016/j.bushor.2011.01.005

Kim, H. J., Kim, T. S., & Sohn, S. Y. (2020). Recommendation of startups as technology cooperation candidates from the perspectives of similarity and potential: A deep learning approach. DECISION SUPPORT SYSTEMS, 130. https://doi.org/10.1016/j.dss.2019.113229

Kirzner, I. M. (1983). Perception, opportunity, and profit. Chicago University Press Chicago, IL, USA.

Kirzner, I. M. (1992). Market Process–Essays in the Development of Modern Austrian Economics. London/New York: Routledge.

Kirzner, I. M. (2015). Competition and entrepreneurship. University of Chicago press.

Klosowski, P. (2018). Deep Learning for Natural Language Processing and Language Modelling. 2018 Signal Processing: Algorithms, Architectures, Arrangements, and Applications (SPA), 223–228. https://doi.org/10.23919/SPA.2018.8563389

Knox, S. (2022). Fostering student engagement in virtual entrepreneurship education environments. The International Journal of Management Education, 20(3), 100705.

Koh, J. H. L., & Daniel, B. K. (2022). Shifting online during COVID-19: A systematic review of teaching and learning strategies and their outcomes. International Journal of Educational Technology in Higher Education, 19(1), 56. https://doi.org/10.1186/s41239-022-00361-7

Kokoç, M. (2021). The mediating role of attention control in the link between multitasking with social media and academic performances among adolescents. Scandinavian Journal of Psychology, 62(4), 493–501.

Kolb, D. A. (2014). Experiential learning: Experience as the source of learning and development. FT press.

Kolvereid, L., & Moen, Ø. (1997). Entrepreneurship among business graduates: Does a major in entrepreneurship make a difference? Journal of European Industrial Training, 21(4), 154–160.

Kosslyn, S. M. (2021). Active learning online: Five principles that make online courses come alive. Alinea Learning.

Kourilsky, M. L., & Walstad, W. B. (2002). The early environment and schooling experiences of high-technology entrepreneurs: Insights for entrepreneurship education. International Journal of Entrepreneurship Education, 1(1), 1–20.

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. Theory into Practice, 41(4), 212–218.

Kraus, S., Niemand, T., Angelsberger, M., Mas-Tur, A., & Roig-Tierno, N. (2017). Antecedents of international opportunity recognition in born global firms. Journal of Promotion Management, 23(3), 386–406.

Kraus, S., Palmer, C., Kailer, N., Kallinger, F. L., & Spitzer, J. (2018). Digital entrepreneurship: A research agenda on new business models for the twenty-first century. International Journal of Entrepreneurial Behavior & Research.

Krishnamurthy, S. (2020). The future of business education: A commentary in the shadow of the Covid-19 pandemic. Journal of Business Research, 117, 1–5.

Kriz, W. C., & Auchter, E. (2016). 10 Years of Evaluation Research Into Gaming Simulation for German Entrepreneurship and a New Study on Its Long-Term

Effects. Simulation & Gaming, 47(2), 179–205. https://doi.org/10.1177/1046878116633972
Krueger Jr, N. F. (2007). What lies beneath? The experiential essence of entrepreneurial thinking. Entrepreneurship Theory and Practice, 31(1), 123–138.
Kucuk, S., Aydemir, M., Yildirim, G., Arpacik, O., & Goktas, Y. (2013). Educational technology research trends in Turkey from 1990 to 2011. Computers & Education, 68, 42–50. https://doi.org/10.1016/j.compedu.2013.04.016
Kulik, J. A., & Fletcher, J. D. (2016). Effectiveness of intelligent tutoring systems: A meta-analytic review. Review of Educational Research, 86(1), 42–78.
Kuratko, D. F. (1996). Risk, challenge & innovation: The entrepreneurial experience at Ball State University. American Journal of Business.
Kuratko, D. F. (2005). The emergence of entrepreneurship education: Development, trends, and challenges. Entrepreneurship Theory and Practice, 29(5), 577–597.
Kurmanov, N., Aliyeva, Z., Kabdullina, G., & Mutaliyeva, L. (2020). Digital entrepreneurship competencies among students: Methodological aspects of the maturity level and development program making. Journal of Entrepreneurship Education, 23(2), 1–11.
Küttim, M., Kallaste, M., Venesaar, U., & Kiis, A. (2014). Entrepreneurship Education at University Level and Students' Entrepreneurial Intentions. Procedia - Social and Behavioral Sciences, 110, 658–668. https://doi.org/10.1016/j.sbspro.2013.12.910
Kwilinski, A., Litvin, V., Kamchatova, E., Polusmiak, J., & Mironova, D. (2021). Information support of the entrepreneurship model complex with the application of cloud technologies. International Journal of Entrepreneurship, 25(1), 1–8.
Laitinen, K., & Valo, M. (2018). Meanings of communication technology in virtual team meetings: Framing technology-related interaction. 32.
Lambert, S. R. (2020). Do MOOCs contribute to student equity and social inclusion? A systematic review 2014–18. Computers & Education, 145, 103693. https://doi.org/10.1016/j.compedu.2019.103693
Lameras, P., Tsiatsos, T., Petridis, P., Tolis, D., Liarokapis, F., Anastasiadou, D., Protopsaltis, A., Hendrix, M., & Arnab, S. (2015). Creative thinking experimentations for entrepreneurship with a disruptive, personalised and mobile game-based learning ecosystem. 5.
Landers, R. N., Auer, E. M., Collmus, A. B., & Armstrong, M. B. (2018). Gamification science, its history and future: Definitions and a research agenda. Simulation & Gaming, 49(3), 315–337.
Lans, T., Blok, V., & Wesselink, R. (2014). Learning apart and together: Towards an integrated competence framework for sustainable entrepreneurship in higher education. Journal of Cleaner Production, 62, 37–47. https://doi.org/10.1016/j.jclepro.2013.03.036
Lattacher, W., & Wdowiak, M. A. (2020). Entrepreneurial learning from failure. A systematic review. International Journal of Entrepreneurial Behavior & Research, 26(5), 1093–1131.
Lazear, E. P. (2004). Balanced skills and entrepreneurship. American Economic Review, 94(2), 208–211.
Le Dinh, T., Vu, M. C., & Ayayi, A. (2018). Towards a living lab for promoting the digital entrepreneurship process. International Journal of Entrepreneurship, 22(1), 1–17.
Leitner, P., Khalil, M., & Ebner, M. (2017). Learning analytics in higher education—A literature review. Learning Analytics: Fundaments, Applications, and Trends, 1–23.
Lepine, J. A., Colquitt, J. A., & Erez, A. (2000). ADAPTABILITY TO CHANGING TASK CONTEXTS: EFFECTS OF GENERAL COGNITIVE ABILITY, CONSCIENTIOUSNESS, AND OPENNESS TO EXPERIENCE. Personnel Psychology, 53(3), 563–593. https://doi.org/10.1111/j.1744-6570.2000.tb00214.x

Lewis, V. L., & Churchill, N. C. (1983). The five stages of small business growth. University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship.

Li, Y. (2018). An application of EDM: Design of a new online system for correcting exam paper. 2018 13th International Conference on Computer Science & Education (ICCSE), 1–6.

Liang, Y., Wang, H., & Hong, W.-C. (2021). Sustainable development evaluation of innovation and entrepreneurship education of clean energy major in colleges and universities based on SPA-VFS and GRNN optimized by chaos bat algorithm. Sustainability, 13(11), 5960.

Liguori, E. W., Winkler, C., Zane, L. J., Muldoon, J., & Winkel, D. (2021). COVID-19 and necessity-based online entrepreneurship education at US community colleges. Journal of Small Business and Enterprise Development, 28(6), 821–830.

Liguori, E., & Winkler, C. (2020). From Offline to Online: Challenges and Opportunities for Entrepreneurship Education Following the COVID-19 Pandemic. Entrepreneurship Education and Pedagogy, 3(4), 346–351. https://doi.org/10.1177/2515127420916738

Lilleväli, U., & Täks, M. (2017). Competence models as a tool for conceptualizing the systematic process of entrepreneurship competence development. Education Research International, 2017.

Lima, E., Lopes, R. M., Nassif, V., & Silva, D. (2015). Opportunities to improve entrepreneurship education: Contributions considering Brazilian challenges. Journal of Small Business Management, 53(4), 1033–1051.

Liñán, F. (2004). Intention-based models of entrepreneurship education. Piccolla Impresa/Small Business, 3(1), 11–35.

Litman, D. (2016). Natural language processing for enhancing teaching and learning. Thirtieth AAAI Conference on Artificial Intelligence.

Liu, H., Kulturel-Konak, S., & Konak, A. (2021). Key elements and their roles in entrepreneurship education ecosystem: Comparative review and suggestions for sustainability. Sustainability, 13(19), 10648.

Liu, I. F., Chen, M. C., Sun, Y. S., Wible, D., & Kuo, C. H. (2010). Extending the TAM model to explore the factors that affect Intention to Use an Online Learning Community. Computers and Education, 54(2), 600–610. https://doi.org/10.1016/j.compedu.2009.09.009

Liu, M., Gorgievski, M. J., Qi, J., & Paas, F. (2022). Increasing teaching effectiveness in entrepreneurship education: Course characteristics and student needs differences. Learning and Individual Differences, 96, 102147.

Liu, M., McKelroy, E., Corliss, S. B., & Carrigan, J. (2017). Investigating the effect of an adaptive learning intervention on students' learning. Educational Technology Research and Development, 65(6), 1605–1625.

Liu, T., Walley, K., Pugh, G., & Adkins, P. (2020). Entrepreneurship education in China: Evidence from a preliminary scoping study of enterprising tendency in Chinese university students. Journal of Entrepreneurship in Emerging Economies, 12(2), 305–326.

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, 869.

Löbler, H. (2006). Learning entrepreneurship from a constructivist perspective. Technology Analysis & Strategic Management, 18(1), 19–38. https://doi.org/10.1080/09537320500520460

Lu, J. (2022). Data science in the business environment: Insight management for an Executive MBA. The International Journal of Management Education, 20(1), 100588.

Luan, H., & Tsai, C.-C. (2021). A review of using machine learning approaches for precision education. Educational Technology & Society, 24(1), 250–266.

Lumpkin, G. T., & Lichtenstein, B. B. (2005). The role of organizational learning in the opportunity–recognition process. Entrepreneurship Theory and Practice, 29(4), 451–472.

Luo, H., Chen, Y., Chen, T., Koszalka, T. A., & Feng, Q. (2023). Impact of role assignment and group size on asynchronous online discussion: An experimental study. Computers & Education, 192, 104658. https://doi.org/10.1016/j.compedu.2022.104658

Luo, Y., Huang, Y., & Wang, S. L. (2012). "Guanxi" and Organizational Performance: A Meta-Analysis. Management and Organization Review, 8(1), 139–172. https://doi.org/10.1111/j.1740-8784.2011.00273.x

Lyu, J., Shepherd, D. M., & Lee, K. (2021). Teaching entrepreneurship in China: Culture matters. International Journal of Entrepreneurial Behavior & Research, 27(5), 1285–1310.

Ma, H., Lang, C., Liu, Y., & Gao, Y. (2020). Constructing a Hierarchical Framework for Assessing the Application of Big Data Technology in Entrepreneurship Education. FRONTIERS IN PSYCHOLOGY, 11. https://doi.org/10.3389/fpsyg.2020.551389

Ma, W., Adesope, O. O., Nesbit, J. C., & Liu, Q. (2014). Intelligent tutoring systems and learning outcomes: A meta-analysis. Journal of Educational Psychology, 106(4), 901.

Mahendra, A. M., Djatmika, E. T., & Hermawan, A. (2017). The Effect of Entrepreneurship Education on Entrepreneurial Intention Mediated by Motivation and Attitude among Management Students, State University of Malang, Indonesia. International Education Studies, 10(9), 61–69.

Man, T. W., Lau, T., & Chan, K. F. (2002). The competitiveness of small and medium enterprises: A conceptualization with focus on entrepreneurial competencies. Journal of Business Venturing, 17(2), 123–142.

Man, T. W. Y. (2007). Understanding Entrepreneurial Learning. 8(3), 10.

Man, T. W. Y., Lau, T., & Chan, K. F. (2002). The competitiveness of small and medium enterprises A conceptualization with focus on entrepreneurial competencies$. Journal of Business Venturing, 20.

Manca, S., & Ranieri, M. (2013). Is it a tool suitable for learning? A critical review of the literature on Facebook as a technology-enhanced learning environment. Journal of Computer Assisted Learning, 29(6), 487–504. https://doi.org/10.1111/jcal.12007

Marín-Marín, J.-A., López-Belmonte, J., Fernández-Campoy, J.-M., & Romero-Rodríguez, J.-M. (2019). Big data in education. A bibliometric review. Social Sciences, 8(8), 223.

Maritz, A., Jones, C., & Shwetzer, C. (2015). The status of entrepreneurship education in Australian universities. Education + Training, 57(8/9), 1020–1035. https://doi.org/10.1108/ET-04-2015-0026

Marques, C. S., Santos, G., Galvão, A., Mascarenhas, C., & Justino, E. (2018). Entrepreneurship education, gender and family background as antecedents on the entrepreneurial orientation of university students. International Journal of Innovation Science.

Marques, L. A., & Albuquerque, C. (2020). Entrepreneurship education going remote- A response to Covid-19 restrictions. 23(2), 9.

Martin, F., Sun, T., & Westine, C. D. (2020). A systematic review of research on online teaching and learning from 2009 to 2018. Computers & Education, 159, 104009.

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, 309–350.

Mason, C., & Arshed, N. (2013). Teaching entrepreneurship to university students through experiential learning: A case study. Industry and Higher Education, 27(6), 449–463.

Mathews, C. H., & Moser, S. B. (1995). Family background and gender: Implications for interest in small firm ownership. Entrepreneurship & Regional Development, 7(4), 365–378. https://doi.org/10.1080/08985629500000023

Matlay, H., & Carey, C. (2007). Entrepreneurship education in the UK: A longitudinal perspective. Journal of Small Business and Enterprise Development, 14(2), 252–263.

Matthews, C. H., & Moser, S. B. (1996). A longitudinal investigation of the impact of family background. Journal of Small Business Management, 34(2), 29–43.
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.
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.
Mayordomo, R. M., & Onrubia, J. (2015). Work coordination and collaborative knowledge construction in a small group collaborative virtual task. The Internet and Higher Education, 25, 96–104.
Mazman, S. Gu., & Usluel, Y. K. (2010). Modeling educational usage of Facebook. 10.
McAdam, M., & Marlow, S. (2008). A preliminary investigation into networking activities within the university incubator. International Journal of Entrepreneurial Behavior & Research, 14(4), 219–241.
McAfee, A., & Brynjolfsson, E. (2012). Big Data: The Management Revolution. 9.
McConnell, D. (2018). E-learning in Chinese higher education: The view from inside. Higher Education, 75(6), 1031–1045. https://doi.org/10.1007/s10734-017-0183-4
McFarland, K. (2017). Entrepreneurship Education and Experiential E-Learning: A Literature Review. Developments in Business Simulation and Experiential Learning: Proceedings of the Annual ABSEL Conference, 44.
McLoughlin, C., & Lee, M. J. W. (2010). Personalised and self regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software. Australasian Journal of Educational Technology, 26(1), 28–43. https://doi.org/10.14742/ajet.1100
Menkhoff, T., & Bengtsson, M. L. (2012). Engaging students in higher education through mobile learning: Lessons learnt in a Chinese entrepreneurship course. Educational Research for Policy and Practice, 11(3), 225–242. https://doi.org/10.1007/s10671-011-9123-8
Mennecke, B. E., Mcneill, D., Ganis, M., Roche, E. M., & Bray, D. A. (2008). Supply Chain and Information Systems Publications Supply Chain and Information Systems Second Life and Other Virtual Worlds: A Roadmap for Research. Supply Chain and Information Systems Publications, 3.
Mennecke, B., Hassall, L. M., & Triplett, J. (2008). The mean business of second life: Teaching entrepreneurship, technology and e-commerce in immersive environments. MERLOT Journal of Online Teaching and Learning, 4(3), 339–348.
Mensah, M. S., Arthur, K. N., & Mensah-Williams, E. (2022). Experiential Learning in Online Entrepreneurship Education: Lessons from an Undergraduate Entrepreneurship Course. In Theorising Undergraduate Entrepreneurship Education (pp. 333–351). Springer.
Meyer, J. P., & Zhu, S. (2013). Fair and equitable measurement of student learning in MOOCs: An introduction to item response theory, scale linking, and score equating. Research & Practice in Assessment, 8, 26–39.
Miles, M. P., de Vries, H., Harrison, G., Bliemel, M., De Klerk, S., & Kasouf, C. J. (2017). Accelerators as authentic training experiences for nascent entrepreneurs. Education+ Training.
Miller, T. L., Wesley, C. L., & Williams, D. E. (2012). Educating the minds of caring hearts: Comparing the views of practitioners and educators on the importance of social entrepreneurship competencies. Academy of Management Learning & Education, 11(3), 349–370.
Mitchell, R. K., Busenitz, L., Lant, T., McDougall, P. P., Morse, E. A., & Smith, J. B. (2002). Toward a theory of entrepreneurial cognition: Rethinking the people side of entrepreneurship research. Entrepreneurship Theory and Practice, 27(2), 93–104.

Mitchelmore, S., & Rowley, J. (2010). Entrepreneurial competencies: A literature review and development agenda. International Journal of Entrepreneurial Behavior & Research.

Mitchelmore, S., & Rowley, J. (2013). Entrepreneurial competencies of women entrepreneurs pursuing business growth. Journal of Small Business and Enterprise Development, 20(1), 125–142. https://doi.org/10.1108/14626001311298448

Mmbaga, N. A., Mathias, B. D., Williams, D. W., & Cardon, M. S. (2020). A review of and future agenda for research on identity in entrepreneurship. Journal of Business Venturing, 35(6), 106049.

Moberg, K. (2014). Two approaches to entrepreneurship education: The different effects of education for and through entrepreneurship at the lower secondary level. The International Journal of Management Education, 12(3), 512–528.

Moldoveanu, M., & Narayandas, D. (2019). The future of leadership development. Harvard Business Review, 97(2), 40–48.

Molleman, E. (2005). Diversity in demographic characteristics, abilities and personality traits: Do faultlines affect team functioning? Group Decision and Negotiation, 14(3), 173–193.

Montebruno, P., Bennett, R. J., Smith, H., & van Lieshout, C. (2020). Machine learning classification of entrepreneurs in British historical census data. INFORMATION PROCESSING & MANAGEMENT, 57(3). https://doi.org/10.1016/j.ipm.2020.102210

Moore, J. L., Dickson-Deane, C., & Galyen, K. (2010). E-Learning, online learning, and distance learning environments: Are they the same? Internet and Higher Education, 14(2), 129–135. https://doi.org/10.1016/j.iheduc.2010.10.001

Morris, M. H., Webb, J. W., Fu, J., & Singhal, S. (2013). A Competency-Based Perspective on Entrepreneurship Education: Conceptual and Empirical Insights. Journal of Small Business Management, 51(3), 352–369. https://doi.org/10.1111/jsbm.12023

Morrison, A., Breen, J., & Ali, S. (2003). Small business growth: Intention, ability, and opportunity. Journal of Small Business Management, 41(4), 417–425.

Motta, V. F., & Galina, S. V. R. (2023). Experiential learning in entrepreneurship education: A systematic literature review. Teaching and Teacher Education, 121, 103919.

Muangprathub, J., Boonjing, V., & Chamnongthai, K. (2020). Learning recommendation with formal concept analysis for intelligent tutoring system. Heliyon, 6(10), e05227. https://doi.org/10.1016/j.heliyon.2020.e05227

Mueller, B. A., Wolfe, M. T., & Syed, I. (2017). Passion and grit: An exploration of the pathways leading to venture success. Journal of Business Venturing, 32(3), 260–279.

Müller, R., & Antoni, C. H. (2020). Individual perceptions of shared mental models of information and communication technology (ICT) and virtual team coordination and performance—The moderating role of flexibility in ICT use. Group Dynamics: Theory, Research, and Practice, 24(3), 186–200. https://doi.org/10.1037/gdn0000130

Munn, Z., Peters, M. D. J., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. BMC Medical Research Methodology, 18(1), 143. https://doi.org/10.1186/s12874-018-0611-x

Nabi, G., Liñán, F., Fayolle, A., Krueger, N., & Walmsley, A. (2017). The impact of entrepreneurship education in higher education: A systematic review and research agenda. Academy of Management Learning & Education, 16(2), 277–299.

Nabi, G., Walmsley, A., Liñán, F., Akhtar, I., & Neame, C. (2018). Does entrepreneurship education in the first year of higher education develop entrepreneurial intentions? The role of learning and inspiration. Studies in Higher Education, 43(3), 452–467. https://doi.org/10.1080/03075079.2016.1177716

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. Academy of Management Review, 23(2), 242–266.
Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. Entrepreneurship Theory and Practice, 41(6), 1029–1055.
Nambisan, S., & Baron, R. A. (2013). Entrepreneurship in innovation ecosystems: Entrepreneurs' self–regulatory processes and their implications for new venture success. Entrepreneurship Theory and Practice, 37(5), 1071–1097.
Navío-Marco, J., & Solórzano-García, M. (2019). Student's social e-reputation ("karma") as motivational factor in MOOC learning. Interactive Learning Environments, 1–15. https://doi.org/10.1080/10494820.2019.1579237
Neumeyer, X. (2021). Implementing data analytics into the entrepreneurship curriculum: A course overview. In Annals of Entrepreneurship Education and Pedagogy–2021. Edward Elgar Publishing.
Newbery, R., Lean, J., & Moizer, J. (2016). Evaluating the impact of serious games: The effect of gaming on entrepreneurial intent. Information Technology and People, 29(4), 733–749. https://doi.org/10.1108/ITP-05-2015-0111
Ngoasong, M. Z. (2017). Digital entrepreneurship in a resource-scarce context: A focus on entrepreneurial digital competencies. Journal of Small Business and Enterprise Development.
Ngoc Khuong, M., & Huu An, N. (2016). The Factors Affecting Entrepreneurial Intention of the Students of Vietnam National University—A Mediation Analysis of Perception toward Entrepreneurship. Journal of Economics, Business and Management, 4(2), 104–111. https://doi.org/10.7763/joebm.2016.v4.375
Nielsen, J. (1993). Usability engineering. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 4970 LNCS, 527–554. https://doi.org/10.1007/978-3-540-70552-9_21
Niemiec, R. M. (2019). Finding the golden mean: The overuse, underuse, and optimal use of character strengths. Counselling Psychology Quarterly, 32(3–4), 453–471. https://doi.org/10.1080/09515070.2019.1617674
Nisheva, M., Gourova, E., & Antonova, A. (2009). ICT and Entrepreneurship Skills at FMI. 8.
Nissen, H. A., Evald, M. R., & Clarke, A. H. (2014). Knowledge sharing in heterogeneous teams through collaboration and cooperation: Exemplified through Public–Private-Innovation partnerships. Industrial Marketing Management, 43(3), 473–482. https://doi.org/10.1016/j.indmarman.2013.12.015
Nokelainen. (2006). Interoperability of educational systems—Editorial of special issue. Educational Technology and Society, 9(2), 1–3.
Noroozi, O., Pijeira-Díaz, H. J., Sobocinski, M., Dindar, M., Järvelä, S., & Kirschner, P. A. (2020). Multimodal data indicators for capturing cognitive, motivational, and emotional learning processes: A systematic literature review. Education and Information Technologies, 25(6), 5499–5547.
Nowiński, W., Haddoud, M. Y., Lančarič, D., Egerová, D., & Czeglédi, C. (2019). The impact of entrepreneurship education, entrepreneurial self-efficacy and gender on entrepreneurial intentions of university students in the Visegrad countries. Studies in Higher Education, 44(2), 361–379. https://doi.org/10.1080/03075079.2017.1365359
Obschonka, M., & Audretsch, D. B. (2020). Artificial intelligence and big data in entrepreneurship: A new era has begun. Small Business Economics, 55(3), 529–539.
O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. The Internet and Higher Education, 25, 85–95. https://doi.org/10.1016/j.iheduc.2015.02.002
Oliver, P. G., & Oliver, S. (2022). Innovative online learning in entrepreneurship education: The impact of embedding real-life industry practice in the virtual learning environment. Industry and Higher Education, 36(6), 756–767.

Olson, J. S. (2017). Helping first-year students get grit: The impact of intentional assignments on the development of grit, tenacity, and perseverance. Journal of The First-Year Experience & Students in Transition, 29(1), 99–118.

Olson-Buchanan, J. B., Sahatjian, Z., & Sterling, C. M. (2020). Walk the talk: Incorporating virtual team research in the classroom. Industrial and Organizational Psychology, 13(4), 474–478. https://doi.org/10.1017/iop.2020.81

Olugbola, S. A. (2017). Exploring entrepreneurial readiness of youth and startup success components: Entrepreneurship training as a moderator. Journal of Innovation & Knowledge, 2(3), 155–171.

Oosterbeek, H., van Praag, M., & IJsselstein, A. (2008). The impact of entrepreneurship education on entrepreneurship competencies and intentions: An evaluation of the Junior Achievement Student Mini-Company Program.

Oosterbeek, H., van Praag, M., & Ijsselstein, A. (2010). The impact of entrepreneurship education on entrepreneurship skills and motivation. European Economic Review, 54(3), 442–454. https://doi.org/10.1016/j.euroecorev.2009.08.002

Otis, N., Grouzet, F. M., & Pelletier, L. G. (2005). Latent motivational change in an academic setting: A 3-year longitudinal study. Journal of Educational Psychology, 97(2), 170.

Oumlil, R., & Juiz, C. (2018). Acceptance of tourism e-entrepreneurship: Application to educational Balearic Islands Context. Journal of Entrepreneurship Education, 21(1), 1–16.

Packham, G., Jones, P., Miller, C., Pickernell, D., & Thomas, B. (2010). Attitudes towards entrepreneurship education: A comparative analysis. Education+ Training, 52(8/9), 568–586.

Padilla-Meléndez, A., Fernández-Gámez, M. A., & Molina-Gómez, J. (2014). Feeling the risks: Effects of the development of emotional competences with outdoor training on the entrepreneurial intent of university students. International Entrepreneurship and Management Journal, 10, 861–884.

Palasundram, K., Sharef, N. M., Nasharuddin, N., Kasmiran, K., & Azman, A. (2019). Sequence to sequence model performance for education chatbot. International Journal of Emerging Technologies in Learning (IJET), 14(24), 56–68.

Palmer, C., Fasbender, U., Kraus, S., Birkner, S., & Kailer, N. (2021). A chip off the old block? The role of dominance and parental entrepreneurship for entrepreneurial intention. Review of Managerial Science, 15(2), 287–307.

Pandey, S., Pandey, S. K., & Miller, L. (2017). Measuring innovativeness of public organizations: Using natural language processing techniques in computer-aided textual analysis. International Public Management Journal, 20(1), 78–107.

Paray, Z. A., & Kumar, S. (2020). Does entrepreneurship education influence entrepreneurial intention among students in HEI's? Journal of International Education in Business, 13(1), 55–72. https://doi.org/10.1108/JIEB-02-2019-0009

Parrish, C. W., Guffey, S. K., & Williams, D. S. (2021). The impact of team-based learning on students' perceptions of classroom community. Active Learning in Higher Education, 14697874211035078.

Pavlidou, I., Dragicevic, N., & Tsui, E. (2021). A multi-dimensional hybrid learning environment for business education: A knowledge dynamics perspective. Sustainability, 13(7), 3889.

Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). Artificial intelligence in education: Challenges and opportunities for sustainable development.

Pei, L., & Wu, H. (2019). Does online learning work better than offline learning in undergraduate medical education? A systematic review and meta-analysis. Medical Education Online, 24(1), 1666538.

Pérez, J. Q., Daradoumis, T., & Puig, J. M. M. (2020). Rediscovering the use of chatbots in education: A systematic literature review. Computer Applications in Engineering Education, 28(6), 1549–1565.

Perry, J. T., Chandler, G. N., & Markova, G. (2012). Entrepreneurial effectuation: A review and suggestions for future research. Entrepreneurship Theory and Practice, 36(4), 837–861.
Petridou, E., & Sarri, K. (2011). Developing "Potential Entrepreneurs" In Higher Education Institutes. Journal of Enterprising Culture, 19, 79–99.
Pham, M. T., Rajić, A., Greig, J. D., Sargeant, J. M., Papadopoulos, A., & McEwen, S. A. (2014). A scoping review of scoping reviews: Advancing the approach and enhancing the consistency. Research Synthesis Methods, 5(4), 371–385.
Pietrosemoli, L., & Rodríguez-Monroy, C. (2019). The Venezuelan energy crisis: Renewable energies in the transition towards sustainability. Renewable and Sustainable Energy Reviews, 105, 415–426.
Pimmer, C., Brühlmann, F., Odetola, T. D., Oluwasola, D. O., Dipeolu, O., & Ajuwon, A. J. (2019). Facilitating professional mobile learning communities with instant messaging. Computers & Education, 128, 102–112.
Pisoň, Z. (2020). The Future of Tech Startups in Central & Eastern Europe. Bratislava: GLOBSEC Policy Institute. Retrieved from https://www. globsec ….
Pittaway, L. (2021). Entrepreneurship Education in Higher Education: A Review of the US Context. Available at SSRN 3942514.
Pittaway, L., & Cope, J. (2007). Entrepreneurship education: A systematic review of the evidence. International Small Business Journal, 25(5), 479–510.
Pittaway, L., & Edwards, C. (2012). Assessment: Examining practice in entrepreneurship education. Education+ Training.
Popenici, S. A. D., & Kerr, S. (2017). Exploring the Impact of Artificial Intelligence on Teaching and Learning in Higher Education. Research and Practice in Technology Enhanced Learning, 12. https://doi.org/10.1186/s41039-017-0062-8
Potter, J. (2008). Entrepreneurship and higher education: Future policy directions.
Potter, J. (2008). Local Economic and Employment Development (Program), & Organisation for Economic Co-operation and Development (Eds.). Entrepreneurship and higher education / edited by Jonathan Potter. Organisation for Economic Co-operation and Development.
Potts, J., & Rennie, E. (2019). Web3 and the creative industries: How blockchains are reshaping business models. In A research agenda for creative industries (pp. 93–111). Edward Elgar Publishing.
Powell, B. C. (2013). Dilemmas in entrepreneurship pedagogy. Journal of Entrepreneurship Education, 16, 99.
Premand, P., Brodmann, S., Almeida, R., Grun, R., & Barouni, M. (2016). Entrepreneurship education and entry into self-employment among university graduates. World Development, 77, 311–327.
Prendes-Espinosa, P., Solano-Fernández, I. M., & García-Tudela, P. A. (2021). EmDigital to promote digital entrepreneurship: The relation with open innovation. Journal of Open Innovation: Technology, Market, and Complexity, 7(1), 63.
Price, A. M., Devis, K., LeMoine, G., Crouch, S., South, N., & Hossain, R. (2018). First year nursing students use of social media within education: Results of a survey. Nurse Education Today, 61, 70–76. https://doi.org/10.1016/j.nedt.2017.10.013
Protopsaltis, A., Hainey, T., Borosis, S., Connolly, T., & Copado, J. (2013). StartUP_EU: Using Game-Based Learning and Web 2.0 Technologies to Teach Entrepreneurship to Secondary Education Students. 14.
Protopsaltis, A., Hetzner, S., Borotis, S., Connolly, T., & Hainey, T. (2014). How to teach entrepreneurship using serious games and web 2.0. Proceedings - IEEE 14th International Conference on Advanced Learning Technologies, ICALT 2014, 227–229. https://doi.org/10.1109/ICALT.2014.72
Pua, S., Ahmad, N. A., & Khambari, M. N. M. (2021). Identification and Analysis of Core Topics in Educational Artificial Intelligence Research: A Bibliometric Analysis. Cypriot Journal of Educational Sciences, 16(3), 995–1009.
Purzer, E., & Fila, N. (2016). Evaluation Of Current Assessment Methods In -Engineering Entrepreneurship Education. Entrepreneurship Education, 27.

Qasim, D., Bany Mohammed, A., & Liñán, F. (2020). The Theoretical Basis of Relevant E-Entrepreneurship Results: A Systematic Literature Review. International Journal of Entrepreneurship and Small Business, 1–30.

Ragusa, A. T., & Crampton, A. (2018). Sense of connection, identity and academic success in distance education: Sociologically exploring online learning environments. Rural Society, 27(2), 125–142.

Rahim, H. L., Kamaruddin, M., Lajin, N. F. M., Buyong, S. Z., & Bakri, A. A. (2015). ENTREPRENEURSHIP EDUCATION IN MALAYSIA: A CRITICAL REVIEW. 02(02), 11.

Raisch, S., & Krakowski, S. (2021). Artificial intelligence and management: The automation–augmentation paradox. Academy of Management Review, 46(1), 192–210.

Rajabion, L., Wakil, K., Badfar, A., Nazif, M., & Ehsani, A. (2019). A new model for evaluating the effect of cloud computing on the e-learning development. Journal of Workplace Learning.

Ramoglou, S., & Tsang, E. W. (2016). A realist perspective of entrepreneurship: Opportunities as propensities. Academy of Management Review, 41(3), 410–434.

Rashid, L. (2019). Entrepreneurship Education and Sustainable Development Goals: A literature Review and a Closer Look at Fragile States and Technology-Enabled Approaches. Sustainability, 11(19), 5343. https://doi.org/10.3390/su11195343

Rasmussen, E. A., & Sørheim, R. (2006). Action-based entrepreneurship education. Technovation, 26(2), 185–194. https://doi.org/10.1016/j.technovation.2005.06.012

Ratten, V. (2013). Cloud computing: A social cognitive perspective of ethics, entrepreneurship, technology marketing, computer self-efficacy and outcome expectancy on behavioural intentions. Australasian Marketing Journal (AMJ), 21(3), 137–146. https://doi.org/10.1016/j.ausmj.2013.02.008

Ratten, V. (2020). Coronavirus (Covid-19) and the entrepreneurship education community. Journal of Enterprising Communities: People and Places in the Global Economy, 14(5), 753–764. https://doi.org/10.1108/JEC-06-2020-0121

Ratten, V., & Jones, P. (2021a). Covid-19 and entrepreneurship education: Implications for advancing research and practice. The International Journal of Management Education, 19(1), 100432.

Ratten, V., & Jones, P. (2021b). Entrepreneurship and management education: Exploring trends and gaps. The International Journal of Management Education, 19(1), 100431.

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.

Reddy, P., Sharma, B., & Chaudhary, K. (2020). Digital literacy: A review of literature. International Journal of Technoethics (IJT), 11(2), 65–94.

Reid, A., & Gilmore, A., Kolb, A., Stefan, K., Jauhola, E. (2018). Internationalization of Entrepreneurial Marketing Education: Three Nations Project.

Reis, E. (2011). The lean startup. New York: Crown Business, 27, 2016–2020.

Remold, S. (2012). Understanding specialism when the jack of all trades can be the master of all. Proceedings of the Royal Society B: Biological Sciences, 279(1749), 4861–4869.

Resei, C., Friedl, C., & Żur, A. (2018). MOOCs and entrepreneurship education-contributions, opportunities and gaps. International Entrepreneurship Review, 4(3), 151–166.

Rhee, K. S., & White, R. J. (2007). The emotional intelligence of entrepreneurs. Journal of Small Business & Entrepreneurship, 20(4), 409–425.

Rippa, P. (2018). Digital academic entrepreneurship_ The potential of digital technologies on academic entrepreneurship. Technological Forecasting, 12.

Robinson, S., Neergaard, H., Tanggaard, L., & Krueger, N. F. (2016). New horizons in entrepreneurship education: From teacher-led to student-centered learning.

Education + Training, 58(7/8), 661–683. https://doi.org/10.1108/ET-03-2016-0048

Robledo, S., Grisales Aguirre, A. M., Hughes, M., & Eggers, F. (2021). “Hasta la vista, baby”–will machine learning terminate human literature reviews in entrepreneurship? Journal of Small Business Management, 1–30.

Robles, M., & Braathen, S. (2002). Online assessment techniques. Delta Pi Epsilon Journal, 44(1), 39–49.

Rodriguez, O. (2013). The concept of openness behind c and x-MOOCs (Massive Open Online Courses). Open Praxis, 5(1), 67–73. https://doi.org/10.5944/openpraxis.5.1.42

Rogers, P., & Lea, M. (2005). Social presence in distributed group environments: The role of social identity. Behaviour & Information Technology, 24(2), 151–158. https://doi.org/10.1080/01449290410001723472

Romero, M., & Usart, M. (2013). Serious games integration in an entrepreneurship Massive Online Open Course (MOOC). Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 8101 LNCS, 212–225. https://doi.org/10.1007/978-3-642-40790-1_21

Rong, G., Mendez, A., Assi, E. B., Zhao, B., & Sawan, M. (2020). Artificial intelligence in healthcare: Review and prediction case studies. Engineering, 6(3), 291–301.

Rosero, A., Dinh, F., de Visser, E. J., Shaw, T., & Phillips, E. (2021). Two Many Cooks: Understanding Dynamic Human-Agent Team Communication and Perception Using Overcooked 2. ArXiv:2110.03071 [Cs]. http://arxiv.org/abs/2110.03071

Rubens, A., Schoenfeld, G. A., Schaffer, B. S., & Leah, J. S. (2018). Self-awareness and leadership: Developing an individual strategic professional development plan in an MBA leadership course. The International Journal of Management Education, 16(1), 1–13.

Rueda, L., Benitez, J., & Braojos, J. (2017). From traditional education technologies to student satisfaction in Management education: A theory of the role of social media applications. Information and Management, 54(8), 1059–1071. https://doi.org/10.1016/j.im.2017.06.002

Ruiz-Alba, J. L., Soares, A., Rodríguez-Molina, M. A., & Banoun, A. (2019). Gamification and entrepreneurial intentions. Journal of Small Business and Enterprise Development, 26(5), 661–683. https://doi.org/10.1108/JSBED-09-2018-0266

Ruskovaara, E., & Pihkala, T. (2015). Entrepreneurship education in schools: Empirical evidence on the teacher’s role. The Journal of Educational Research, 108(3), 236–249.

Russell, V. (2020). Language anxiety and the online learner. Foreign Language Annals, 53(2), 338–352.

Sabahi, S., & Parast, M. M. (2020). The impact of entrepreneurship orientation on project performance: A machine learning approach. International Journal of Production Economics, 226, 107621.

Saha, S. K., & Rao C. H., D. (2022). Development of a Practical System for Computerized Evaluation of Descriptive Answers of Middle School Level Students. Interactive Learning Environments, 30(2), 215–228. https://doi.org/10.1080/10494820.2019.1651743

Salas, E., Grossman, R., Hughes, A. M., & Coultas, C. W. (2015). Measuring Team Cohesion: Observations from the Science. Human Factors: The Journal of the Human Factors and Ergonomics Society, 57(3), 365–374. https://doi.org/10.1177/0018720815578267

Salas-Pilco, S. Z., & Yang, Y. (2022). Artificial intelligence applications in Latin American higher education: A systematic review. International Journal of Educational Technology in Higher Education, 19(1), 1–20.

Salas-Rueda, R.-A. (2021). Analysis of Facebook in the Teaching-Learning Process about Mathematics through Data Science. Canadian Journal of Learning and Technology, 47(2). https://eric.ed.gov/?q=education+machine+learning&id=EJ1324681

Samad, S., Nilashi, M., & Ibrahim, O. (2019). The impact of social networking sites on students' social wellbeing and academic performance. Education and Information Technologies, 24(3), 2081–2094. https://doi.org/10.1007/s10639-019-09867-6

Sánchez, J. C. (2013). The Impact of an Entrepreneurship Education Program on Entrepreneurial Competencies and Intention. Journal of Small Business Management, 51(3), 447–465. https://doi.org/10.1111/jsbm.12025

Santateresa, P. I. (2016). Fostering Entrepreneurship in Higher Education, by Problem-Based Learning. In M. Peris-Ortiz, J. A. Gómez, F. Vélez-Torres, & C. Rueda-Armengot (Eds.), Education Tools for Entrepreneurship (pp. 167–182). Springer International Publishing. https://doi.org/10.1007/978-3-319-24657-4_13

Santos, S. C., Morris, M. H., Caetano, A., Costa, S. F., & Neumeyer, X. (2019). Team entrepreneurial competence: Multilevel effects on individual cognitive strategies. International Journal of Entrepreneurial Behavior & Research.

Saptono, A., & Najah, S. (2018). Development of an assessment instrument of affective domain for entrepreneurship in senior high school. Journal of Entrepreneurship Education, 21(4), 1–12.

Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. Academy of Management Review, 26(2), 243–263.

Sarasvathy, S. D. (2009). Effectuation: Elements of entrepreneurial expertise. Edward Elgar Publishing.

Sarooghi, H., Sunny, S., Hornsby, J., & Fernhaber, S. (2019). Design thinking and entrepreneurship education: Where are we, and what are the possibilities? Journal of Small Business Management, 57, 78–93.

Schade, P., & Schuhmacher, M. C. (2023). Predicting entrepreneurial activity using machine learning. Journal of Business Venturing Insights, 19, e00357.

Schiff, D. (2021). Out of the laboratory and into the classroom: The future of artificial intelligence in education. AI & Society, 36(1), 331–348.

Schmitt, A., Rosing, K., Zhang, S. X., & Leatherbee, M. (2018). A dynamic model of entrepreneurial uncertainty and business opportunity identification: Exploration as a mediator and entrepreneurial self-efficacy as a moderator. Entrepreneurship Theory and Practice, 42(6), 835–859.

Schmitz, A., Urbano, D., Dandolini, G. A., de Souza, J. A., & Guerrero, M. (2017). Innovation and entrepreneurship in the academic setting: A systematic literature review. International Entrepreneurship and Management Journal, 13, 369–395.

Schumacher, C., & Ifenthaler, D. (2018). Features students really expect from learning analytics. Computers in Human Behavior, 78, 397–407.

Schumann, H. O. (2019). The use of student-copresented virtual guest speakers in entrepreneurial education. Journal of Education for Business, 94(6), 418–422.

Schumpeter, J., & Backhaus, U. (2003). The theory of economic development. Springer.

Scott, J. M., Pavlovich, K., Thompson, J. L., & Penaluna, A. (2019). Constructive (mis)alignment in team-based experiential entrepreneurship education. Education + Training, 62(2), 184–198. https://doi.org/10.1108/ET-06-2019-0113

Secundo, G., Rippa, P., & Meoli, M. (2020). Digital transformation in entrepreneurship education centres- preliminary evidence from the Italian Contamination Labs network. 17.

Sedkaoui, S. (2018). How data analytics is changing entrepreneurial opportunities? International Journal of Innovation Science.

Sedrakyan, G., Malmberg, J., Verbert, K., Järvelä, S., & Kirschner, P. A. (2020). Linking learning behavior analytics and learning science concepts: Designing a learning analytics dashboard for feedback to support learning regulation. Computers in Human Behavior, 107, 105512.

Seikkula-Leino, J., Ruskovaara, E., Ikavalko, M., Mattila, J., & Rytkola, T. (2010). Promoting entrepreneurship education: The role of the teacher? Education + Training, 52(2), 117–127. https://doi.org/10.1108/00400911011027716

Seikkula-Leino, J., & Salomaa, M. (2020). Entrepreneurial competencies and organisational change—Assessing entrepreneurial staff competencies within higher education institutions. Sustainability, 12(18), 7323.
Seikkula-Leino, J., Satuvuori, T., Ruskovaara, E., & Hannula, H. (2015). How do Finnish teacher educators implement entrepreneurship education? Education+ Training.
Sexton, D. L., Bowman, N. B. (1984). Entrepreneurship education: Suggestions for increasing effectiveness. Journal of Small Business Management, 22(2), 18–25. https://doi.org/10.1016/j.jaci.2012.05.050
Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. Organization Science, 11(4), 448–469.
Shane, S. A. (2003). A general theory of entrepreneurship: The individual-opportunity nexus. Edward Elgar Publishing.
Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. Academy of Management Review, 25(1), 217–226.
Sharma, K., & Giannakos, M. (2020). Multimodal data capabilities for learning: What can multimodal data tell us about learning? British Journal of Educational Technology, 51(5), 1450–1484.
Sharma, K., Papamitsiou, Z., & Giannakos, M. (2019). Building pipelines for educational data using AI and multimodal analytics: A “grey-box” approach. British Journal of Educational Technology, 50(6), 3004–3031.
Shepherd, D. A., Wennberg, K., Suddaby, R., & Wiklund, J. (2019). What are we explaining? A review and agenda on initiating, engaging, performing, and contextualizing entrepreneurship. Journal of Management, 45(1), 159–196.
Shir, N., & Ryff, C. D. (2022). Entrepreneurship, self-organization, and eudaimonic well-being: A dynamic approach. Entrepreneurship Theory and Practice, 46(6), 1658–1684.
Sieger, P., Gruber, M., Fauchart, E., & Zellweger, T. (2016). Measuring the social identity of entrepreneurs: Scale development and international validation. Journal of Business Venturing, 31(5), 542–572.
Sieger, P., Zellweger, T., Fueglistaller, U., & Hatak, I. (2021). Global Student Entrepreneurship 2021: Insights From 58 Countries (2021 GUESSS GLobal Report).
Siemens, G., & Tittenberger, P. (2009). Handbook of Emerging Technologies for Learning. Image Rochester NY, 65.
Silveyra, G., Herrero, Á., & Pérez, A. (2021). Model of teachable entrepreneurship competencies (M-TEC): Scale development. The International Journal of Management Education, 19(1), 100392.
Sirelkhatim, F., & Gangi, Y. (2015). Entrepreneurship education: A systematic literature review of curricula contents and teaching methods. Cogent Business & Management, 2(1), 1052034.
Śledzik, K. (2013). Schumpeter’s view on innovation and entrepreneurship. Management Trends in Theory and Practice,(Ed.) Stefan Hittmar, Faculty of Management Science and Informatics, University of Zilina & Institute of Management by University of Zilina.
Smith, G. G., Haworth, R., & Žitnik, S. (2020). Computer science meets education: Natural language processing for automatic grading of open-ended questions in ebooks. Journal of Educational Computing Research, 58(7), 1227–1255.
Smutny, P., & Schreiberova, P. (2020). Chatbots for learning: A review of educational chatbots for the Facebook Messenger. Computers & Education, 151, 103862.
Solano, Q. P., Hayward, L., Chopra, Z., Quanstrom, K., Kendrick, D., Abbott, K. L., Kunzmann, M., Ahle, S., Schuller, M., & Ötleş, E. (2021). Natural Language Processing and Assessment of Resident Feedback Quality. Journal of Surgical Education, 78(6), e72–e77.
Solomon, G. (2007). An examination of entrepreneurship education in the United States. Journal of Small Business and Enterprise Development, 14(2), 168–182.
Solórzano-García, M., & Navío-Marco, J. (2019). Developing social entrepreneurs through distance education: The value of commitment and interactivity with the learning community. 21.

Song, H., Restivo, M., van de Rijt, A., Scarlatos, L., Tonjes, D., & Orlov, A. (2015). The hidden gender effect in online collaboration: An experimental study of team performance under anonymity. Computers in Human Behavior, 50, 274–282.

Sousa, M. J. (2019). Creating knowledge and entrepreneurial capacity for HE students with digital education methodologies_ Differences in the perceptions of students and entrepreneurs. Journal of Business Research, 14.

Spence, L. J., Schmidpeter, R., & Habisch, A. (2003). Assessing social capital: Small and medium sized enterprises in Germany and the UK. Journal of Business Ethics, 47, 17–29.

Sreelakshmi, A. S., Abhinaya, S. B., Nair, A., & Nirmala, S. J. (2019). A question answering and quiz generation chatbot for education. 2019 Grace Hopper Celebration India (GHCI), 1–6.

Stam, E., & Welter, F. (2020). Geographical contexts of entrepreneurship: Spaces, places and entrepreneurial agency. In The Psychology of Entrepreneurship (pp. 263–281). Routledge.

Stam, W., Arzlanian, S., & Elfring, T. (2014). Social capital of entrepreneurs and small firm performance: A meta-analysis of contextual and methodological moderators. Journal of Business Venturing, 29(1), 152–173.

Staniewski, M. W., & Awruk, K. (2019). Entrepreneurial success and achievement motivation–A preliminary report on a validation study of the questionnaire of entrepreneurial success. Journal of Business Research, 101, 433–440.

Steininger, D. M., Kathryn Brohman, M., & Block, J. H. (2022). Digital Entrepreneurship: What is New if Anything? In Business & Information Systems Engineering (pp. 1–14). Springer.

Stuetzer, M., Obschonka, M., & Schmitt-Rodermund, E. (2013). Balanced skills among nascent entrepreneurs. Small Business Economics, 41(1), 93–114. https://doi.org/10.1007/s11187-012-9423-2

Sullivan, R. (2000). Entrepreneurial learning and mentoring. International Journal of Entrepreneurial Behavior & Research, 6(3), 160–175.

Suryavanshi, T., Lambert, S., Lal, S., Chin, A., & Chan, T. M. (2020). Entrepreneurship and Innovation in Health Sciences Education: A Scoping Review. Medical Science Educator, 30(4), 1797–1809. https://doi.org/10.1007/s40670-020-01050-8

Susi, T., Johannesson, M., Backlund, P. (2007). Serious Games – An Overview. 2017 IEEE 8th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference, UEMCON 2017, 2018-Janua, 488–491. https://doi.org/10.1109/UEMCON.2017.8249059

Swan, K., Garrison, D. R., & Richardson, J. C. (2009). A constructivist approach to online learning: The community of inquiry framework. In Information technology and constructivism in higher education: Progressive learning frameworks (pp. 43–57). IGI global.

Swaramarinda, D. R. (2018). The usefulness of information and communication technology in entrepreneurship subject. Journal of Entrepreneurship Education, 21(3), 1–10.

Taatila, V. P. (2010). Learning entrepreneurship in higher education. Education+ Training.

Talan, T. (2021). Artificial Intelligence in Education: A Bibliometric Study. International Journal of Research in Education and Science, 7(3), 822–837.

Tang, K.-Y., Chang, C.-Y., & Hwang, G.-J. (2021). Trends in artificial intelligence-supported e-learning: A systematic review and co-citation network analysis (1998–2019). Interactive Learning Environments, 1–19.

Tarabasz, A., Selaković, M., & Abraham, C. (2018). The Classroom of the Future: Disrupting the Concept of Contemporary Business Education. 17.

Taşkın, N., & Kılıç Çakmak, E. (2022). Effects of gamification on behavioral and cognitive engagement of students in the online learning environment. International Journal of Human–Computer Interaction, 1–12.

Tasnim, R. (2013). Playing Entrepreneurship: Can Games Make a Difference? 15.

Taylor, D. W., & Thorpe, R. (2004). Entrepreneurial learning: A process of co-participation. Journal of Small Business and Enterprise Development, 11(2), 203–211. https://doi.org/10.1108/14626000410537146

Teng, T.-L., & Taveras, M. (2004). Combining live video and audio broadcasting, synchronous chat, and asynchronous open forum discussions in distance education. Journal of Educational Technology Systems, 33(2), 121–129.

Tess, P. A. (2013). The role of social media in higher education classes (real and virtual)–A literature review. Computers in Human Behavior, 29(5), A60–A68.

Teymurova, V., Abdalova, M., Babayeva, S., Huseynova, V., Mammadov, E., & Islamova, N. (2020). Implementation of Mobile Entrepreneurial Learning in the Context of Flexible Integration of Traditions and Innovations.

Thanasi-Boçe, M. (2020). Enhancing students' entrepreneurial capacity through marketing simulation games. Education+ Training.

Thomas, N. J., & Baral, R. (2023). Mechanism of gamification: Role of flow in the behavioral and emotional pathways of engagement in management education. The International Journal of Management Education, 21(1), 100718.

Thomas, R. S., Bahadori, T., Buckley, T. J., Cowden, J., Deisenroth, C., Dionisio, K. L., Frithsen, J. B., Grulke, C. M., Gwinn, M. R., & Harrill, J. A. (2019). The next generation blueprint of computational toxicology at the US Environmental Protection Agency. Toxicological Sciences, 169(2), 317–332.

Thormann, J., & Fidalgo, P. (2014). Guidelines for online course moderation and community building from a student's perspective. Journal of Online Learning & Teaching, 10(3), 374–388.

Tkachenko, V., Kuzior, A., & Kwilinski, A. (2019). Introduction of artificial intelligence tools into the training methods of entrepreneurship activities. Journal of Entrepreneurship Education, 22(6), 1–10.

Toledo, I., Albornoz, C., & Schneider, K. (2020). Learning Analytics to Explore Dropout in Online Entrepreneurship Education. Psychology, 11(02), 268–284. https://doi.org/10.4236/psych.2020.112017

Townsend, D. M., Hunt, R. A., McMullen, J. S., & Sarasvathy, S. D. (2018). Uncertainty, knowledge problems, and entrepreneurial action. Academy of Management Annals, 12(2), 659–687.

Tracey, P., & Phillips, N. (2011). Entrepreneurship in emerging markets: Strategies for new venture creation in uncertain institutional contexts. Management International Review, 51, 23–39.

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., … Straus, S. E. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Annals of Internal Medicine, 169(7), 467–473. https://doi.org/10.7326/M18-0850

Tsai, H. S., Jiang, M., Alhabash, S., LaRose, R., Rifon, N. J., & Cotten, S. R. (2016). Understanding online safety behaviors: A protection motivation theory perspective. Computers & Security, 59, 138–150.

Turker, D., & Selcuk, S. S. (2009). Which factors affect entrepreneurial intention of university students? Journal of European Industrial Training.

Turnbull, D., Chugh, R., & Luck, J. (2021). Issues in learning management systems implementation: A comparison of research perspectives between Australia and China. Education and Information Technologies, 26(4), 3789–3810. https://doi.org/10.1007/s10639-021-10431-4

Turner, K., & Stough, C. (2020). Pre-service teachers and emotional intelligence: A scoping review. The Australian Educational Researcher, 47(2), 283–305. https://doi.org/10.1007/s13384-019-00352-0

Turner, T., & Gianiodis, P. (2018). Entrepreneurship unleashed: Understanding entrepreneurial education outside of the business school. Journal of Small Business Management, 56(1), 131–149.

Unger, J. M., Rauch, A., Frese, M., & Rosenbusch, N. (2011). Human capital and entrepreneurial success: A meta-analytical review. Journal of Business Venturing, 26(3), 341–358.

Vabalas, A., Gowen, E., Poliakoff, E., & Casson, A. J. (2019). Machine learning algorithm validation with a limited sample size. PloS One, 14(11), e0224365.

Vaghely, I. P., & Julien, P.-A. (2010). Are opportunities recognized or constructed?: An information perspective on entrepreneurial opportunity identification. Journal of Business Venturing, 25(1), 73–86.

Vagos, P., Rodrigues, P. F., Pandeirada, J. N., Kasaeian, A., Weidenauer, C., Silva, C. F., & Randler, C. (2019). Factorial structure of the Morningness-Eveningness-Stability-Scale (MESSi) and sex and age invariance. Frontiers in Psychology, 10, 3.

Valliere, D. (2013). Towards a schematic theory of entrepreneurial alertness. Journal of Business Venturing, 28(3), 430–442. https://doi.org/10.1016/j.jbusvent.2011.08.004

van Bonn, S. M., Grajek, J. S., Schneider, A., Oberhoffner, T., Mlynski, R., & Weiss, N. M. (2022). Interactive live-stream surgery contributes to surgical education in the context of contact restrictions. European Archives of Oto-Rhino-Laryngology, 279(6), 2865–2871.

van Ginkel, S., Gulikers, J., Biemans, H., Noroozi, O., Roozen, M., Bos, T., van Tilborg, R., van Halteren, M., & Mulder, M. (2019). Fostering oral presentation competence through a virtual reality-based task for delivering feedback. Computers & Education, 134, 78–97.

Venkatesh, V., & Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science, 46(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Shaw, J. D., Sykes, T. A., Wamba, S. F., & Macharia, M. (2017). Networks, Technology, and Entrepreneurship: A Field Quasi-experiment among Women in Rural India. Academy of Management Journal, 60(5), 1709–1740. https://doi.org/10.5465/amj.2015.0849

Versteijlen, M., Salgado, F. P., Groesbeek, M. J., & Counotte, A. (2017). Pros and cons of online education as a measure to reduce carbon emissions in higher education in the Netherlands. Current Opinion in Environmental Sustainability, 28, 80–89.

Vesper, K. H., & Gartner, W. B. (1997). Measuring progress in entrepreneurship education. Journal of Business Venturing, 12(5), 403–421. https://doi.org/10.1016/S0883-9026(97)00009-8

Vial, G. (2021). Understanding digital transformation: A review and a research agenda. Managing Digital Transformation, 13–66.

Viberg, O., Hatakka, M., Bälter, O., & Mavroudi, A. (2018). The current landscape of learning analytics in higher education. Computers in Human Behavior, 89, 98–110.

Villanueva, J., Van de Ven, A. H., & Sapienza, H. J. (2012). Resource mobilization in entrepreneurial firms. Journal of Business Venturing, 27(1), 19–30.

Volery, T., & Lord, D. (2000). Critical success factors in online education. International Journal of Educational Management.

von Graevenitz, G., Harhoff, D., & Weber, R. (2010). The effects of entrepreneurship education. Journal of Economic Behavior & Organization, 76(1), 90–112. https://doi.org/10.1016/j.jebo.2010.02.015

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

Vorbach, S., Poandl, E. M., & Korajman, I. (2019). Digital entrepreneurship education: The role of MOOCs. International Journal of Engineering Pedagogy, 9(3).

Wadhwa, V., & Aggarwal, R. (2009). Anatomy of an entrepreneur: Family background and motivation.pdf. 24.

Waghid, Z. (2017). Using Film and Online Group Blogs to Cultivate a Community of Inquiry: A Case Studied at a University of Technology in South Africa. Progressio, 38(2), 106–131. https://doi.org/10.25159/0256-8853/2103

Waghid, Z., & Oliver. (2017). Cultivating social entrepreneurial capacities in students through film: Implications for social entrepreneurship education. Educational Research for Social Change, 6(2), 76–100. https://doi.org/10.17159/2221-4070/2017/v6i2a6

Wagner, J. (2003). Testing Lazear's jack-of-all-trades view of entrepreneurship with German micro data. Applied Economics Letters, 10(11), 687–689.

Walsh, L., & Martin, B. (2022). The value of leadership practices when there is no one to lead: A nascent entrepreneurship context. Journal of Small Business Management, 1–37.

Wang, C., Dong, Y., Xia, Y., Li, G., Martínez, O. S., & Crespo, R. G. (2020). Management and entrepreneurship management mechanism of college students based on support vector machine algorithm. Computational Intelligence, coin.12430. https://doi.org/10.1111/coin.12430

Wang, C., Mundorf, N., & Salzarulo-McGuigan, A. (2022). Entrepreneurship education enhances entrepreneurial creativity: The mediating role of entrepreneurial inspiration. The International Journal of Management Education, 20(2), 100570.

Wang, R., Lowe, R., Newton, S., & Kocaturk, T. (2020). Task complexity and learning styles in situated virtual learning environments for construction higher education. Automation in Construction, 113, 103148. https://doi.org/10.1016/j.autcon.2020.103148

Wang, Y. (2016). Big opportunities and big concerns of big data in education. TechTrends, 60(4), 381–384.

Wardana, L. W., Narmaditya, B. S., Wibowo, A., Mahendra, A. M., Wibowo, N. A., Harwida, G., & Rohman, A. N. (2020). The impact of entrepreneurship education and students' entrepreneurial mindset: The mediating role of attitude and self-efficacy. Heliyon, 6(9), e04922.

Warhuus, J. P., Tanggaard, L., Robinson, S., & Ernø, S. M. (2017). From I to We: Collaboration in entrepreneurship education and learning? Education + Training, 59(3), 234–249. https://doi.org/10.1108/ET-08-2015-0077

Warkentin, M., & Beranek, P. M. (1999). Training to improve virtual team communication. Information Systems Journal, 9(4), 271–289. https://doi.org/10.1046/j.1365-2575.1999.00065.x

Watson, J. (2008). Blended Learning: The Convergence of Online and Face-to-Face Education. North American Council for Online Learning, 572, 16. https://doi.org/10.1016/j.aca.2006.05.012

Weiming, L., Chunyan, L., & Xiaohua, D. (2016). Ten years of entrepreneurship education at chinese universities: Evolution, problems, and system building. Chinese Education & Society, 49(3), 198–216.

Weinert, F. E. (1999). Concepts of competence.

Welsh, D., & Dragusin, M. (2013). The new generation of massive open online course (MOOCS) and entrepreneurship education. In Small Business Institute Journal (Vol. 9, Issue 1, p. 51).

Welter, F. (2011). Contextualizing entrepreneurship—Conceptual challenges and ways forward. Entrepreneurship Theory and Practice, 35(1), 165–184.

Wen, M., Yang, D., & Rosé, C. P. (2015). Virtual Teams in Massive Open Online Courses. In C. Conati, N. Heffernan, A. Mitrovic, & M. F. Verdejo (Eds.), Artificial Intelligence in Education (pp. 820–824). Springer International Publishing.

Wetzel, K., Buss, R., Foulger, T. S., & Lindsey, L. (2014). Infusing educational technology in teaching methods courses: Successes and dilemmas. Journal of Digital Learning in Teacher Education, 30(3), 89–103.

Williams, D. (2015). The Impact of SimVenture on the Development of Entrepreneurial Skills in Management Students. Industry and Higher Education, 29(5), 379–395. https://doi.org/10.5367/ihe.2015.0270

Williamson, A. J., Drencheva, A., & Battisti, M. (2022). Entrepreneurial disappointment: Let down and breaking down, a machine-learning study. Entrepreneurship Theory and Practice, 46(6), 1500–1533.

Williamson, O. E. (2000). The new institutional economics: Taking stock, looking ahead. Journal of Economic Literature, 38(3), 595–613.

Wilson, F., Kickul, J., & Marlino, D. (2007). Gender, entrepreneurial self–efficacy, and entrepreneurial career intentions: Implications for entrepreneurship education. Entrepreneurship Theory and Practice, 31(3), 387–406.
Wind, Y. (2008). A plan to invent the marketing we need today. MIT Sloan Management Review, 49(4), 21–28.
Winkler-Schwartz, A., Bissonnette, V., Mirchi, N., Ponnudurai, N., Yilmaz, R., Ledwos, N., Siyar, S., Azarnoush, H., Karlik, B., & Del Maestro, R. F. (2019). Artificial intelligence in medical education: Best practices using machine learning to assess surgical expertise in virtual reality simulation. Journal of Surgical Education, 76(6), 1681–1690.
Wood, M. S., & Williams, D. W. (2014). Opportunity evaluation as rule-based decision making. Journal of Management Studies, 51(4), 573–602.
Wraae, B., Tigerstedt, C., & Walmsley, A. (2020). Using Reflective Videos to Enhance Entrepreneurial Learning. Entrepreneurship Education and Pedagogy, 251512742093695. https://doi.org/10.1177/2515127420936955
Wraae, B., Tigerstedt, C., & Walmsley, A. (2021). Using reflective videos to enhance entrepreneurial learning. Entrepreneurship Education and Pedagogy, 4(4), 740–761.
Wu, S., Chen, R., Wei, G., Gao, X., & Huo, L. (2021). Understanding the Impact of Startups' Features on Investor Recommendation Task via Weighted Heterogeneous Information Network. Complexity, 2021.
Wu, Y. J., Yuan, C. H., & Pan, C. I. (2018). Entrepreneurship education: An experimental study with information and communication technology. In Sustainability (Switzerland) (Vol. 10, Issue 3). https://doi.org/10.3390/su10030691
Wu, Y., & Song, D. (2019). Gratifications for social media use in entrepreneurship courses: Learners' perspective. Frontiers in Psychology, 10(MAY), 1–12. https://doi.org/10.3389/fpsyg.2019.01270
Xie, K., Hensley, L. C., Law, V., & Sun, Z. (2019). Self-regulation as a function of perceived leadership and cohesion in small group online collaborative learning. British Journal of Educational Technology, 50(1), 456–468.
Xu, C., & Zhang, Z. (2021). The Effect of Law Students in Entrepreneurial Psychology Under the Artificial Intelligence Technology. Frontiers in Psychology, 12.
Xu, J. J., & Babaian, T. (2021). Artificial intelligence in business curriculum: The pedagogy and learning outcomes. The International Journal of Management Education, 19(3), 100550.
Xu, S., Zhang, Q., Lü, L., & Mariani, M. S. (2020). Recommending investors for new startups by integrating network diffusion and investors' domain preference. Information Sciences, 515, 103–115.
Xue, S., & Churchill, D. (2022). Educational affordances of mobile social media for language teaching and learning: A chinese teacher's perspective. Computer Assisted Language Learning, 35(4), 918–947.
Yakubu, M. N., Dasuki, S. I., Abubakar, A. M., & Kah, M. M. O. (2020). Determinants of learning management systems adoption in Nigeria: A hybrid SEM and artificial neural network approach. Education and Information Technologies, 25(5), 3515–3539. https://doi.org/10.1007/s10639-020-10110-w
Yang, D., Alsadoon, A., Prasad, P. C., Singh, A. K., & Elchouemi, A. (2018). An emotion recognition model based on facial recognition in virtual learning environment. Procedia Computer Science, 125, 2–10.
Yang, L. P., Xu, D. W., & Wang, W. (2014). The Application of Intelligent Agent in Network Platform for Undergraduate's Innovation and Entrepreneurship Education. Applied Mechanics and Materials, 687, 2149–2152.
Yang, Y., Cho, Y., Mathew, S., & Worth, S. (2011). College student effort expenditure in online versus face-to-face courses: The role of gender, team learning orientation, and sense of classroom community. Journal of Advanced Academics, 22(4), 619–638.
Yin, H., Lu, G., & Wang, W. (2014). Unmasking the teaching quality of higher education: Students' course experience and approaches to learning in China. Assessment &

Evaluation in Higher Education, 39(8), 949–970. https://doi.org/10.1080/02602938.2014.880107

Yılmaz, F., & Çakır, H. (2021). Learning Analytics and Potential Usage Areas in Education. Learning Analytics, 9.

Zawacki-Richter, O., Kerres, M., Bedenlier, S., Bond, M., & Buntins, K. (2020). Systematic reviews in educational research: Methodology, perspectives and application. Springer Nature.

Zawacki-Richter, O., & Latchem, C. (2018). Exploring four decades of research in Computers & Education. Computers & Education, 122, 136–152.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? International Journal of Educational Technology in Higher Education, 16(1), 39. https://doi.org/10.1186/s41239-019-0171-0

Żbikowski, K., & Antosiuk, P. (2021). A machine learning, bias-free approach for predicting business success using Crunchbase data. Information Processing & Management, 58(4), 102555.

Zhai, X. (2022). ChatGPT User Experience: Implications for Education. Available at SSRN 4312418.

Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., Liu, J.-B., Yuan, J., & Li, Y. (2021). A Review of Artificial Intelligence (AI) in Education from 2010 to 2020. Complexity, 2021.

Zhai, X., Yin, Y., Pellegrino, J. W., Haudek, K. C., & Shi, L. (2020). Applying machine learning in science assessment: A systematic review. Studies in Science Education, 56(1), 111–151.

Zhang, Y., & Chan, K. K. (2021). Infusing visual analytics technology with business education: An exploratory investigation in fostering higher-order thinking in China. Innovations in Education and Teaching International, 58(5), 586–595.

Zhao, Y., Srite, M., Kim, S., & Lee, J. (2021). Effect of team cohesion on flow: An empirical study of team-based gamification for enterprise resource planning systems in online classes. Decision Sciences Journal of Innovative Education, 19(3), 173–184.

Zhonggen, Y. (2019). A meta-analysis of use of serious games in education over a decade. International Journal of Computer Games Technology, 2019.

Zhou, M., & Xu, H. (2012). A Review of Entrepreneurship Education for College Students. 17.

Zhou, Y., Huang, C., Hu, Q., Zhu, J., & Tang, Y. (2018). Personalized learning full-path recommendation model based on LSTM neural networks. Information Sciences, 444, 135–152.

Appendix

Questionnaire of the perception of the effectiveness of virtual team learning for entrepreneurship competence

Category	Items
Demography	Gender: Male/ Female
	Age:
	Education: Senior school (secondary vocational school) or under, Vocational or three-year college, Bachelor, Over bachelor
	Education field: Social sciences (e.g., Economics, Law, Education), Natural sciences (e.g., Physics, Biology, Chemistry), Applied sciences (e.g., Civil Engineering, Applied Mathematics), Formal sciences (e.g., Mathematics, Statistics), Humanities sciences (e.g., Literature, Philosophy, History)
	There are self-employees in my family (parents and siblings): Yes/ No
	I have entrepreneurial experience or I am an entrepreneur: Yes/No
Entrepreneurship Competencies (Totally disagree-totally agree 7 Likert Scale)	I can discover possible entrepreneurial opportunities
	I am good at integrating and using the resources I need
	I can complete the task according to the plan
	I often have new or unique ideas
	I know how much money is needed to start a company
	I will make a plan to achieve a goal
	I believe I can successfully start a valuable business
	In working with others, I can establish good relationships with others
	When encountering problems, I can actively face and solve them
	I can learn from my prior experience
	When I meet problems, I don't give up easily
Virtual Team (Totally disagree-totally agree 7 Likert Scale)	I like tasks with moderate difficulty
	I can adopt appropriate strategies or methods to solve the problem
	Various ICT methods have different functions
	Online cooperation has helped me and my team members build a relationship of mutual trust and common goals
	After completing the group task, I still contact with the group members
	When I attend EE courses, I use ICT to communicate and discuss with teammates every time
	I can use a variety of ICT methods proficiently

Curriculum Vitae

Appointments

Since 2021	Research Assistant, Economic and Business Education-Learning, Design, and Technology, Business School, University of Mannheim, Germany

Education

2019	Master of Arts, Pedagogy
	Tongji University, China
2017	Exchange Semester, Asian Studies in Business and Economics,
	Paderborn University, Germany
2014	Bachelor of Arts, Pedagogy
	Fuyang Normal College, China

Teaching activities

Since 2022	Digital Entrepreneurship (third-party organization – Chinese)

Memberships

AERA, AECT