Knowledge Management & E-Learning, Vol.16, No.2. Jun 2024

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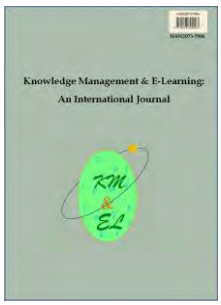

Knowledge Management & E-Learning: An International Journal (KM&EL)
ISSN 2073-7904

Recommended citation:
Hammoda, B. (2024). The impact of educational technologies on entrepreneurial competencies: A systematic review of empirical evidence. *Knowledge Management & E-Learning, 16*(2), 309–333. https://doi.org/10.34105/j.kmel.2024.16.015

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The impact of educational technologies on entrepreneurial competencies: A systematic review of empirical evidence

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Abstract: Researchers and educators have been exploring innovative methods in entrepreneurship education to address traditional approach failure at engaging students and developing their skills. Educational technology has shown promising results in early studies. Yet, there is a scarcity of reviews on their effectiveness in developing entrepreneurial competencies. This paper systematically reviews the empirical literature on the outcomes of educational technology used to teach entrepreneurship at higher education institutions. From an initial 316 search hits, 26 articles were selected for in-depth review. The learning outcomes were translated into entrepreneurial competencies, using the EntreComp Framework as a reference. Findings show that educational technologies, in general, positively impacted entrepreneurial competencies, especially financial & economic literacy, motivation & perseverance, and initiative taking. Gaming and simulations were the most researched, having an overall positive influence, while online learning and MOOCs showed limited and sometimes contradictory effects. The study fills the scholarly gap by connecting educational technology, entrepreneurship education, and entrepreneurial competencies. It provides a basic mapping linking each educational technology to the competencies it develops and advocates for a competency-based pedagogy in the delivery and assessment of entrepreneurship education. Educators can apply the findings and the mapping developed in this study to design and deliver entrepreneurship courses, incorporating educational technologies more insightfully and effectively in their pedagogies.

Keywords: Entrepreneurship education; Educational technology; Competency-based education; Systematic review; Entrepreneurial competency

Biographical notes: Basel Hammoda is a Lecturer and PhD candidate in Entrepreneurship at the Department of Business Administration, Tallinn University of Technology (Taltech) in Estonia. His research focuses on innovative approaches to entrepreneurial learning and its intersection with the wider entrepreneurship and management fields. He has several publications in the field of entrepreneurship, digital technology, and education and is the editor of the Routledge book: "Contemporary Entrepreneurship: Global Perspectives and Cases".

1. Introduction

Entrepreneurship and entrepreneurship education (EE) are linked to socio-economic development (Kuratko, 2011; Ligthelm, 2007; Mojica et al., 2010; Pacheco et al., 2010). EE delivered through higher education institutions (HEI) is valued for shaping students' entrepreneurial mindsets and behaviors (Ploum et al., 2018). However, traditional approaches to EE fail to engage students and nurture their practical skills to a satisfactory level (Gibb, 2002; Neck & Greene, 2011). Hence, in recent years, the use of more innovative methods based on experiential and practical approaches is increasingly being adopted as complementary tools (Ferreira et al., 2018). Researchers have thus called for more studies on reviewing the application and effectiveness of these new methods (Bonesso et al., 2018; Sirelkhatim & Gangi, 2015) to help guide educators work, with Fellnhofer (2019) suggesting that future research on EE pedagogies should focus on the "*How?*" rather than "*What?*".

Educational technologies (ET) are among those innovative methods. They refer to digital artefacts used in teaching to achieve desired learning outcomes (LO). They are regarded as a transformative impetus that can improve the effectiveness and efficiency of education (Papadakis et al., 2017). Their adoption was further hastened with the rapid shift to remote learning during COVID-19 (Ellyton et al., 2022) and the emergence of Generative AI as an educational tool (Hammoda, 2024a), making learning more convenient to the digitally savvy generations (Ratten & Jones, 2023).

ET can enhance the practice-based aspects of EE (Hammoda, 2024b; Schou et al., 2022; Winkler et al., 2023). Educators and researchers are trying, however, to find an effective approach to incorporate them into pedagogies (Ratten & Usmanij, 2021). This mapping exercise is becoming a necessity, as technology is expected to dominate EE in the near future (Ratten & Usmanij, 2021). A major obstacle is our limited understanding of how the LO can be identified as competencies (Harden, 2002), especially when applying ET in EE (Antonaci et al., 2015). The competency-based approach is indeed argued to be more suitable in assessing the effectiveness of EE, compared to socio-economic factors which predominate scholarly discussions (Nabi et al., 2017; Neck & Greene, 2011). Nonetheless, current reviews on this topic are scarce. Those available had either referred to it marginally as part of a wider pedagogical review (e.g., Rashid, 2019; Secundo et al., 2020), or focused on a narrow set of ET (e.g., Chen et al., 2021; Lin & Sekiguchi, 2020).

This paper fills our scholarly gap by reviewing empirical articles on the impact of the different types of ET when applied in EE within HEIs, using a systematic literature review methodology. It synthesizes the identified LO in those studies into entrepreneurial competencies (EC) using the EntreComp framework as a reference tool. EntreComp, which was developed by the European Commission in 2016, is a modular framework that exhibits essential EC and is widely adopted in entrepreneurship research and teaching (Bacigalupo et al., 2016). The following research question is pursued in this paper: How does the application of educational technologies in entrepreneurship education affect the development of entrepreneurial competencies among HEIs students?. Put simply, we aim to find whether educational technologies had a positive or negative impact on the development of the different entrepreneurial competencies of the students and to what extent.

The resultant map of the competencies developed by each ET is the main contribution of this study. It can be used as a basic model for EE researchers and educators to build upon in their studies and apply it in their classrooms for better integration of ET in

their curricula and to evaluate their students' progress. It hence contributes to advocating competency-based education as a suitable pedagogical approach in EE and contributes to the scarce research in this area. The paper is structured as follows: in the next section, we review relevant literature on entrepreneurship education and competencies, and educational technologies applications. We then explain the methodology of our systematic review. Afterwards, we report and discuss the descriptive findings and the competencies developed by each ET in the reviewed articles. Finally, we conclude by highlighting the implications, and limitations and indicate areas for future research focus.

2. Literature review

2.1. Entrepreneurship education

Entrepreneurship education can be defined as "*any pedagogical program or process of education for entrepreneurial attitudes and skills, which involve developing certain personal qualities.*" (Fayolle, 2006). In the last two decades, entrepreneurship courses have spread across most levels and disciplines at HEIs (Sousa et al., 2019), with pedagogical approaches and populations becoming highly diverse (Rideout & Gray, 2013). Hence, several scholars (e.g., Loi & Fayolle, 2021; Pittaway & Cope, 2007) argued for the need to review the fragmented literature on EE methods, with a special focus on their outcomes (Rashid, 2019).

EE methods can be classified into traditional, such as lectures and reading materials, which were found not suitable for the dynamic nature of entrepreneurship (Huebscher & Lendner, 2010; Mwasalwiba, 2010) and active/experiential approaches that use case studies, educational technologies, and extra-curricular activities (Kuratko & Morris, 2018). The latter has witnessed increasing adoption of HEIs to engage younger generations and operationalize EE (Fay¬olle et al., 2006; Kasurinen & Knutas, 2018). According to Jones and Colwill (2013), the choice of teaching style and method should relate to the nature of the learners. Given that the newer generations are naturally digitally savvy, using ET can elicit better adoption, facilitate EE delivery, and improve LO (Neergaard & Christensen, 2017). Moreover, ET which involves active learning techniques can help instill core entrepreneurial and business skills in students (Klapper & Tegtmeier, 2010).

2.2. Educational technology

Technology has become a constant in every aspect of life (Vorbach et al., 2019), and the education sector is no different, with technology becoming a core component of educational reforms (Mavlutova et al., 2020; Papadakis et al., 2017). These reforms can incrementally improve the quality and feasibility of education (Hammoda, 2024; Papadakis et al., 2017), with wide-spread digitalization expected to offer unlimited opportunities to improve the educational and learning process (Mavlutova et al., 2020). Educational technology is defined as the facilitation of learning by the application of technology (Januszewski & Molenda, 2013). Their propagated application in recent years has increased the attractiveness of the education system as it improved students' engagement and allowed them to have better access and flexibility in their learning journey (Gianesini et al., 2018; Qureshi et al., 2021; Winter & Hammoda, 2024). ET is particularly relevant to new generations who are adept at technology and hence brings a sense of familiarity to

them and contributes to a student-centered approach (Oyelere et al., 2016), which was proven to better develop learners' competencies (Wu et al., 2018). Tretyakova et al. (2021) predict that HEIs will become heavily reliant on ET in the near future.

Educational technology can play a key role in the evolution and promotion of EE towards stronger economic and societal impact (Ratten & Jones, 2021). They are introduced in EE curricula to augment the learning experience of the students, increase the appeal of EE especially among younger generations, and improve the learning outcomes. Indeed, ET is argued to improve entrepreneurial competencies and mindset (Chen et al., 2021; Fayolle, 2013), with recent years witnessing an increasing use of various ET in business and entrepreneurship education (Chen et al., 2021). These include gaming and simulations (Chaudhary, 2008), virtual and augmented reality (Papadakis et al., 2020), multimedia (Wu et al., 2018), big data and related technologies (Mavlutova et al., 2020). Moreover, they allow for more efficient student-centered learning through personalization of content and the learning process. Hence, enhancing its convenience and the engagement of the students (Cooper, 2007; Wu et al., 2018; Tretyakova et al., 2021). However, there are several challenges hindering the propagation of ET in EE. These include institutional support, financial costs, training of entrepreneurship educators, application among larger classes, educational oversights, and required technological and physical infrastructure (Hammoda, 2024).

However, research on the application of ET in EE is still in its infancy (Lin & Sekiguchi, 2020; Rashid, 2019), with scholars calling for better exploration of this nexus (Ratten & Jones, 2021). This can provide a better understanding of the intricacies of applying innovative technologies in EE (Fellnhofer, 2019), and propagate best practices (Nixon et al., 2018). In addition, there is a lack of reviews on the outcomes of the different technology-based methods in EE (Chen et al., 2021).

2.2.1. Previous reviews of educational technology in entrepreneurship education

A few reviews have examined the intersection of ET and EE. Two of these reviews marginally touched on the application of ET in EE as part of a wider scope, yet their conclusions support the argument for conducting this study. The first is Secundo et al. (2020), who explored the ascending role of ET in academic entrepreneurship. In their review, they mention examples of technologies such as augmented reality, additive manufacturing, and social networks that are revolutionizing several aspects of the educational process. They put the applications of ET in EE as a top avenue for future research in this field. Moreover, Rashid (2019) in his review of the role of EE in promoting sustainable development goals, argues that some of the available technologies (e.g., learning management systems (LMS), mobile platforms, and serious games) can help develop certain EC that traditional EE methods fell short of addressing such as creativity, problem-solving skills, cooperation, and teamwork.

Two other reviews were more focused on the role of ET in EE. The first is Lin and Sekiguch's systematic review of e-learning in EE (2020). Although they only reviewed EE in online settings, their findings and conclusions warrant attention. Their most salient remark is the clear insufficiency of research in this area, as they identified 41 articles only over a 20-year period (2000-2020). The second review was conducted by Chen et al. (2021). They covered a broader scope of ET used in online and blended EE settings and organized the 38 articles they reviewed into three categories: games, social media, and MOOCs. They stated that each technology has its merits and its challenges, thus it is up to the educator to

decide which technology to use and for what purpose. Both studies called for more reviews on the utilization and effectiveness of ET in EE, which aligns with Fayolle's earlier remarks (2013) on the absence of systematic reviews in this area.

2.3. Competency-based entrepreneurship education

Competency-based education is an outcome-based approach that orchestrates the different pedagogical approaches and activities to equip students with the intended skills, knowledge, and attitudes to achieve the desired LO (Gervais, 2016; Morris et al., 2013). Entrepreneurs need to acquire and apply a set of competencies in their quest to transform opportunities into viable businesses (Vestergaard et al., 2012), with EE regarded as a key enabler in developing them (Morris et al., 2013).

Identifying a concrete set of EC, however, has been difficult due to the variety of settings, types, and understandings of the field of entrepreneurship. Hence, in recent years an EU-commissioned team of researchers managed to identify a set essential EC through a rigorous review of literature and a series of experts' consultations. They developed the Entrepreneurship Competency Framework, also known as EntreComp, as a basic framework that can be adapted and leveraged by individuals and organizations for skills development, innovation, and venture creation (Bacigalupo et al., 2016). The EntreComp is made up of three competency areas: '*Ideas and opportunities*', '*Resources'* and '*Into action*' (see Fig. 1), with a total of 15 competencies across them (ibid). In recent years, it has become the most established competency framework in entrepreneurship research, education, and its assessment (López-Núñez et al., 2022; Morselli & Gorenc, 2022). It is especially relevant in educational settings as a measure of the generic LO (European Commission, 2016).

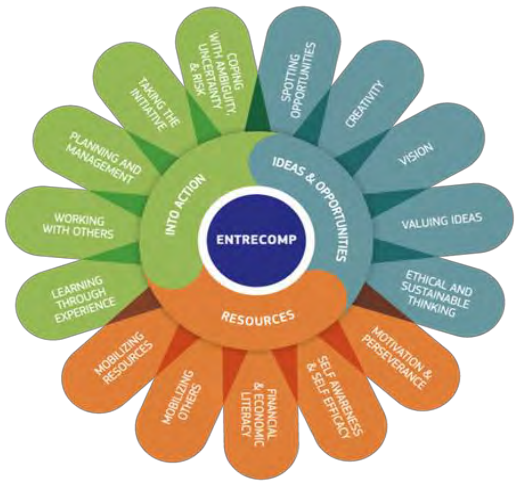

Fig. 1. EntreComp framework, Adapted from Bacigalupo et al. (2016)

Several scholars called for the adoption of more formative measures to assess EE outcomes, rather than socio-economic factors such as startup rates, with EC regarded as more suitable for a comprehensive assessment of EE contributions (Glackin & Phelan, 2020; Nabi et al., 2017; Neergaard & Christensen, 2017). This aligns with ongoing reforms to promote competency-based approaches in HEIs, especially in EE programmes (Glackin & Phelan, 2020), as it equips students with transformative skills and competencies that they can use in different personal, career, and social contexts (Bacigalupo et al., 2016; Fayolle et al., 2006).

3. Methods

The study employed a systematic literature review which is typically used to analyse state-of-the-art research on a given topic (Massaro et al., 2016; Petticrew & Roberts, 2006; Rauch, 2020). It is often conducted in entrepreneurship research (Tranfield et al., 2003) and helps guide future research efforts (Denyer & Tranfield, 2009). We followed Jesson et al. (2011) six steps approach to systematic reviews, which are: 1) Mapping the field through a scoping review, 2) Comprehensive search, 3) Quality assessment, by reading and selecting qualified papers, 4) Data extraction, by collecting needed data from reviewed papers and storing them in an excel sheet with predetermined columns, 5) Synthesis of the extracted data to show the known and to provide the basis for establishing the unknown, and 6) Write-up.

The author, together with a research assistant, first discussed and agreed upon the database, search keywords, inclusion, and exclusion criteria. These were selected to fulfill the purpose of the study in critically assessing the empirical literature investigating the impact of ET on LO when used for EE at HEIs. An Excel sheet was produced and used in analysing the articles with specific criteria (columns) mirroring our research interests. We primarily relied on the Scopus database as it has the largest coverage in social sciences (Mishra et al., 2017; Rew, 2020; Thelwall, 2018; Waltman, 2016). The search keywords were synthesized from previous literature reviews in this area (e.g., Chen et al., 2021; Lin & Sekiguchi, 2020) and expanded to include more educational technologies (Hammoda, 2024).

The initial search generated 316 hits. These were articles published anytime until 30 June 2023. A review of the title, abstract and in some cases in-depth reading of other sections was needed to keep only articles that are relevant to the purpose of our study. The inclusion criteria were empirical journal articles, that went through a peer review process as it assures quality and validity (Podsakoff et al., 2005), with the sample being students in HEIs across any discipline, educational level, or geography, and a focus on reporting LO of applying ET in EE. We excluded conference publications, book chapters, and conceptual and review papers. We also excluded papers with a different focus beyond the purpose of this research, such as those addressing established entrepreneurs or investigating the impact on educators and the institution; focusing on the technology design or adoption rates and not the learning outcomes; or reporting on nonspecific learning outcomes. After incorporating the inclusion and exclusion criteria, a final count of 26 scientific articles was chosen for the in-depth analysis. The search string and the search process are depicted in Fig. 2.

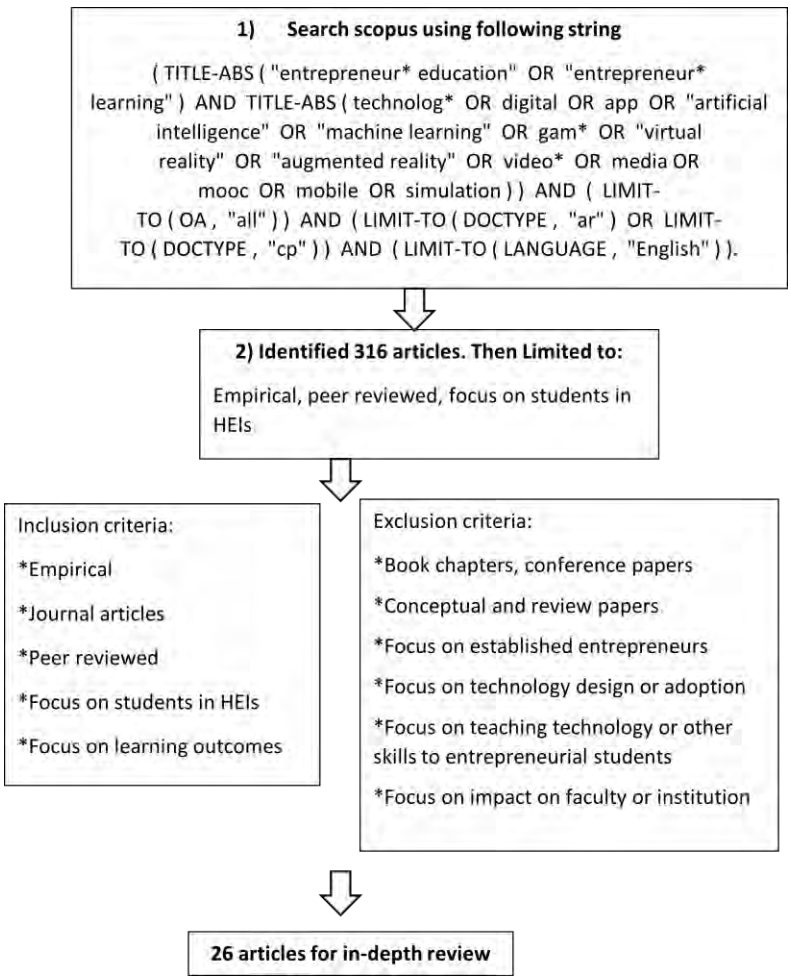

Fig. 2. Systematic review stages

We collected descriptive data on the geography, journals, publication years, theories, research methods, and technologies. The focus of the analysis, however, was on the reported learning outcomes to answer our main research question. These were extracted from the findings and discussion sections in those papers and translated into the corresponding competencies as exhibited in the EntreComp framework (Bacigalupo et al., 2016). This was done by the author and reviewed by the research assistant, following a thematic analysis approach (Neuendorf, 2018). The similarity was 92.6% (150 out of 162 translations) and for the debated translations (N = 12), we discussed between us and reached a consensus. The above-mentioned methodology allowed us to review and present the state of the art on ET (Levy & Ellis, 2006) and their entrepreneurial learning outcomes, and develop a body of validated knowledge to guide EE research and practice.

4. Results

In the descriptive part of our findings (see Table 1), we provide details with regard to the name of the journals, including their primary focus, the year of publication, and the geographical location of the study. We also account for the used theories, methodological approaches, and the ET investigated in each of them. We then expound on ET outcomes by mapping the technologies in those articles to the entrepreneurial competencies they influenced, as the main contribution of this paper.

4.1. Descriptive findings

The empirical research on the role of ET in developing EC among HEI entrepreneurial students is clearly fragmented with the 26 articles spread across 20 different journals in various fields. Surprisingly, the most popular outlets were Frontiers in Psychology ($N = 5$) and Sustainability ($N = 3$), which are not primarily focused on entrepreneurship or education. The field of study is a nascent one indeed, with most studies appearing in the last 5 years only (22 out of 26 articles). Moreover, to address the specific research question, we limited our sample to those articles that reported clearly on the learning outcomes of applied educational technologies. Hence, the relatively small number of articles in our sample which is not uncommon in this niche (see Chen et al., 2021; Lin & Sekiguchi, 2020; Secundo et al., 2020) or in specific phenomena in education (Bendermacher et al., 2017). However, a few pioneering studies emerged more than 10 years ago (Cooper, 2007; Huebscher & Lendner, 2010), although their work was based on desktop-based technologies that were the standard then. The 26 investigated articles were conducted in 19 different countries: 11 in Europe, 6 in Asia and 2 in North America. Only one research (Mavlutova et al., 2020), was conducted across several countries: Lithuania, Latvia, Italy, Belgium, and Portugal.

The most utilized theoretical framework was that of the planned behavior of Ajzen (1991). It was used in several studies including Bandera et al. (2018); Dabbous and Boustani (2023); Dong and Tu (2021); Isabelle (2020); and Newbery et al. (2016). Other theories were applied seldomly such as uses and gratification, experiential learning, constructivist learning, and UTAUT. Several studies, however, did not rely on an established theoretical model. Most of the reviewed papers adopted a quantitative approach via closed-ended questionnaires (19 out of 26), with multiple studies applying an experimental approach with pre- and post-test questionnaires. A few articles employed a mixed-method approach or qualitative-only methods.

4.2. Educational technologies and their impact on learning outcomes and entrepreneurial competencies

Through the studied papers, several technologies were used to enhance the delivery of EE to students. We grouped them into seven categories based on the nature and the use of each of them (gaming and simulation, big data such as Artificial Intelligence and machine learning, massive open online courses, computer-assisted tools, virtual and augmented realities, and online communities). Although some studies combined multiple modalities, we assigned them to the technology group that chiefly impacted students' competencies. We then reviewed the LO in the findings and discussion sections of each of the articles and mapped them against the EC and their description as listed on the EntreComp (Bacigalupo et al., 2016). The EC impacted by each of the ETs is demonstrated in Fig. 3.

Table 1
Overview of the reviewed articles

Articles	Journal	Geography	Main theoretical model	Main technology group
Ahsan and Faletehan (2021)	Cakrawala Pendidikan	Indonesia	N/A	Simulation & gaming
Bandera et al. (2018)	International Journal of Management Education	US	Theory of Planned Behavior	Online communities & online education
Chen and Yu (2020)	Frontiers in Psychology	China	Personality Development Theory	AI & ML
Chen et al. (2022)	Frontiers in Psychology	China	N/A	Simulation & gaming
Cooper (2007)	Active Learning in Higher Education	UK	N/A	Computer-assisted & multimedia
Dabbous and Boustani (2023)	Journal of Risk and Financial Management	Lebanon	Theory of Planned Behavior	AI & ML
Dong and Tu (2021)	Mathematical Problems in Engineering	Thailand	Theory of Planned Behavior	Virtual & augmented realities
Grivokostopoulou et al. (2019)	Sustainability	Greece	Self-determination Theory	Simulation & gaming; Virtual & augmented realities
Huebscher and Lendner (2010)	Journal of Small Business and Entrepreneurship	Germany	Constructivist Learning	Simulation & gaming
Isabelle (2020)	Decision Sciences Journal of Innovative Education	Canada	Theory of Planned Behavior	Simulation & gaming
Kang and Lee (2020)	Education and Information Technologies	Korea	Project-based Learning	Computer assisted & multimedia
Kriz and Auchter (2016)	Simulation and Gaming	Germany	Logic Model	Simulation & gaming
Lyons et al. (2023)	Education + Training	Ireland	N/A	Simulation & gaming
Mavlutova et al. (2020)	WSEAS Transactions on Environment and Development	Latvia, Lithuania, Belgium, Italy and Portugal	N/A	AI & ML
Newbery et al. (2016)	Information Technology and People	UK	Theory of Planned Behaviour	Simulation & gaming
Oliver and Oliver (2022)	Industry & Higher Education	UK	Experiential Learning	Online education
Park and Kim (2023)	Sustainability	Korea	N/A	Simulation & gaming
Pratikto et al. (2021)	International Journal of Interactive Mobile Technologies	Indonesia	Design thinking	Simulation & gaming
Samašonok et al. (2020)	Entrepreneurship and Sustainability Issues	Lithuania	N/A	Simulation & gaming
Vorbach et al. (2019)	International Journal of Engineering Pedagogy	Switzerland	N/A	MOOCs
Widjaja et al. (2022)	Entrepreneurial Business and Economics Review	Indonesia	UTAUT	Online education
Wu et al. (2018)	Sustainability	Taiwan	N/A	Computer assisted & multimedia
Wu et al. (2019)	Frontiers in Psychology	Taiwan	Affective domain	MOOCs
Wu and Song (2019)	Frontiers in Psychology	China	Uses and gratification theory	Online communities
Yang et al. (2022)	Frontiers in Psychology	China	Learning Process 3P model9	Simulation & gaming
Zuo et al. (2021)	International Journal of Emerging Technologies in Learning	Russia	N/A	MOOCs

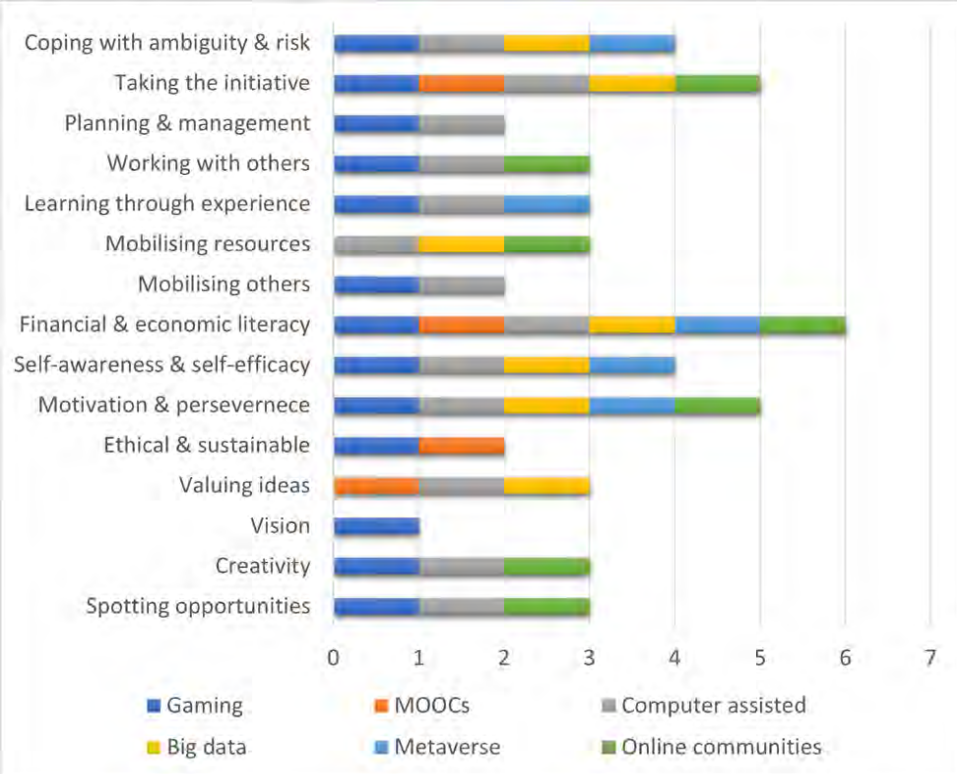

Fig. 3. Entrepreneurial competencies that educational technologies helped develop

4.2.1. Gaming and simulations

In our analysis, gaming and simulation were the most studied technology group (12 out of 26 articles), with some delivered on desktops and centrally administered (e.g., Huebscher & Lendner, 2010), while the rest delivered through mobile platforms (e.g., Pratikto et al., 2021) or virtual reality environment (e.g., Grivokostopoulou et al., 2019). Simulations were found to have the most positive impact on developing most of the ECs, especially "*planning & management*", "*financial & economic literacy*" and "*working with others*".

For example, Huebscher & Lendner (2010) surveyed more than 2,000 entrepreneurship students involved in gaming seminars over 5 years in Germany and found that it helped them understand economics, strategy and marketing, work in a team, and practice business planning and management. Ahsan & Faletehan (2021) found coinciding results when surveying hundreds of undergraduate university students over 9 years. Game-based EE helped them acquire entrepreneurial knowledge, better communicate with others, and perform business processes. In the same vein, Lyons et al. (2023) conducted two separate case studies using a digital enterprise module among first-year students and found it to significantly improve their engagement and motivation. It also helped them understand different entrepreneurial topics, and improve their digital, innovation, and communication skills. Grivokostopoulou et al., (2019) found that game-based learning helped students acquire financial and management concepts in their experiment with 86 university students. Pratiko et al. (2021) ran a posttest among vocational students, after using a design thinking

approach to develop serious game requirements. They found that it helped them understand business concepts such as market analysis, operating costs, pricing, and profitability. Chen et al. (2022) conducted a quasi-experimental study with the TOP-BOSS simulation software and found it to positively influence entrepreneurial orientation and self-efficacy. Similarly, Park and Kim (2023), ran an experiment with 30 students and reported that the gaming experience improved their intention, self-determination, and self-efficacy. Yang et al. (2022) surveyed students after an entrepreneurship course at Zhongshan Institute, China and found that simulations helped students develop self-efficacy and teamwork skills. Furthermore, Samašonok et al. (2020) surveyed university students to investigate the efficiency conditions and possibilities of using business simulations in EE and found that it helped them with spotting opportunities to start a business, perform tasks creatively, get acquainted with enterprise operations, and learn through practical environments.

However, business simulations were shown by some other authors to have contradictory impacts on "*motivation*" and "*self-efficacy*", which coincides with similar findings in the literature on game-based learning (El Mawas et al., 2022). Newbery et al. (2016) ran a quasi-experiment with questionnaires distributed to 263 first-year university students from business and management discipline. They found it to negatively impact their entrepreneurial intentions, although not significantly. Also, Kriz and Auchter (2016) carried out an online survey to measure the long-term effects of simulation-based startup seminars (EXIST priME Cup) in Germany. Although it had a positive impact on business knowledge and planning competencies, it showed conflicting results when it came to motivation and entrepreneurial intent.

4.2.2. Artificial intelligence and machine learning

Big data technologies such as Artificial Intelligence (AI) and Machine Learning (ML), were of special value in testing students' entrepreneurial ideas, providing recommendations for partners' and investors' selection, performing market analysis and evaluating business plans. Thus, helping to-be entrepreneurs develop several competencies including "*self-awareness & self-efficacy*", "*valuing ideas*", "f*inancial & economic literacy*" and "*mobilizing resources*". Mavlutova et al. (2020) surveyed 947 undergraduate and master's students from five European countries mainly, after using AI-supported software to assess and improve their startup ideas. They found that it helped assess the innovativeness, viability, and competitiveness of business ideas; analyse students' personal characteristics and abilities as potential entrepreneurs; examine their business plans; and recommend resources, partnerships; provide incorporation advice; and assess risks and potential mitigation plans. Additionally, Chen and Yu (2020) ran an experiment with 518 entrepreneurship psychology university students leveraging deep neural networks and found it to improve intentions, resilience, optimism, and mental strength. Moreover, Dabbous and Boustani (2023), surveyed 233 postgraduate business students in a university in Lebanon, and found AI to have a positive impact, although indirect, on entrepreneurial intention and self-efficacy.

4.2.3. MOOCs

Learning through MOOCs was convenient to the students and helped develop knowledge-based competencies such as "*financial & economic literacy*" and "*ethical and sustainable thinking*", "*motivations*", and "*initiative taking*". For example, Zuo et al. (2021) surveyed

205 undergraduate students, in the pre and post-implementation of MOOC courses in EE and found it to improve intentions and rates of starting a business. Wu et al. (2019) ran a thematic content analysis of MOOC course feedback and used it to compare the learning performance of students participating in a 9-week blended social entrepreneurship program. They found that students made improved ethical judgements and understood basic business concepts and operations better. Vorbach et al. (2019) surveyed 40 university students from engineering majors and found that it impacted their ability to work in teams, communicate and mobilize others. MOOCs were shown, however, to have a limited impact on developing practice-based EC among students, in comparison to other modes of learning. Also, by missing the opportunity to interact with other students, their social skills and their motivation were negatively impacted.

4.2.4. Computer-assisted tools and multimedia

Computer-assisted tools such as videos and animations, were shown to improve a broad range of skills and competency in a supportive role (e.g., Cooper, 2007; Kang & Lee, 2020; Wu et al., 2018). Cooper (2007) used mixed methods with students enrolled in entrepreneurship courses across multiple university levels, to compare their preferences and effectiveness of using text versus multimedia. He found it to provoke thinking and learning by doing. Kang and Lee (2020) surveyed and interviewed undergraduate students to assess the impact of using computer-assisted technology (Adruino and Raspberry Pi) in entrepreneurship capstone courses. They found it to improve inquisitive, imaginative, interpersonal, technical, and critical thinking skills, among others. Wu et al. (2018) combined a peer-evaluated quasi-experiment with a qualitative analysis of reflective learning reports from MBA students, to examine the effects of animated presentations on procuring entrepreneurial investments. They found it to be helpful in developing new ideas and conveying them in a simpler and more interesting way, developing proof of concepts rapidly, and engaging and persuading investors.

4.2.5. Virtual and augmented realities

Virtual and augmented realities were used to provide entrepreneurship students with immersive and near-life practical experiences (Dong & Tu, 2021; Hammoda, 2023; Grivokostopoulou et al., 2019). They were shown to develop several competencies, including "*self-awareness*" and "*coping with ambiguity, uncertainty and risk*". Dong and Tu (2021) surveyed 400 university students, to understand the influence of VR-aided EE on entrepreneurial intentions. They reported that students improved their willingness and motivation, developed entrepreneurial character and awareness, experienced real situations, and learned to deal with unexpected situations and problems.

4.2.6. Online communities

Participating in online entrepreneurship communities by students influenced the development of most ECs, especially "*spotting opportunities*", "*creativity*", "*taking initiative*", and "*working with others*". Bandera et al. (2018) surveyed tens of undergraduate and MBA university students in entrepreneurship courses and found it to improve opportunity recognition, intention and motivation, and willingness to take on tasks. Wu and Song (2019) used a mixed-method approach through focus groups, interviews and a survey distributed to hundreds of university students, to explore the uses and

gratifications of social media in entrepreneurship courses. They reported that it helped students think about opportunities to generate income, improve their knowledge of business concepts, expand their network among like-minded and supportive people, and take the first step in promoting and selling their products and services through online communities.

4.2.7. Online education

On the contrary, to previously mentioned findings, which are mostly positive, online EE was shown to have minimal impact on competency development. This came as no surprise given the practical nature of EE. Among the competencies that were slightly improved is "*motivation*" in Widjaja et al. (2022) study. In addition, Oliver and Oliver's (2022), case study with postgraduate students found that certain features of online learning platforms such as breakout rooms and discussion boards could be beneficial to develop negotiation skills in a safe public judgement environment and sharing knowledge among learning circles, respectively.

In summation, ET applied for teaching entrepreneurship had to varying degrees a positive impact on the development of the majority of EC, with simulations receiving the main scholarly attention and proving to have the most profound impact. It is worth noting however that across all the studies, a few competencies were minimally affected. These are "*vision*", "*ethical & sustainable thinking*", and "*mobilizing others*". Hence, we have a limited understanding of how ET can help develop those competencies in entrepreneurial settings.

5. Discussion

The recent technological advances and the expansion in technology utilization in education warrant a rising scholarly attention (Hammoda & Foli, 2024). Within the entrepreneurship context, our understanding is still nascent with regard to their application and effectiveness towards developing EC (Gervais, 2016; Morris et al., 2013). Entrepreneurship educators are still conceptualizing possible ways to integrate them into existing pedagogies (Mavlutova et al., 2020). This study systematically reviewed empirical work that reported directly on LO of applying ET in EE and translated those findings into corresponding EC. In comparison to previous reviews, it provides a more concrete understanding of the utility of ET in EE across a more comprehensive set of technologies, that can be promptly applied by entrepreneurship educators.

Indeed, it became more evident from this review that research on the role of technologies in EE is a rather recent one and is clearly fragmented. Moreover, there are geographical discrepancies between our practice of entrepreneurship education and the scholarly efforts investigating the application of technologies in it. Despite the United States pioneering the introduction of entrepreneurship courses in its HEIs (Katz, 2003; Kuratko, 2005), only two studies in our sample were conducted in North America. Comparable findings were also reported in reviews in this niche. Rashid's review (2019), which referred to ET's role in EE, found that only 16% of the total articles had a North American focus. Also, Chen et al. (2021) found only four out of 38 papers emerged from the U.S. (approximately 10%). This might be attributed to either a lag in incorporating ET in entrepreneurship pedagogies or specific challenges in conducting research in this niche.

Additionally, a significant number of the reviewed articles lack sufficient theoretical and methodological rigorousness (Nabi et al., 2017; Zainuddin et al., 2020). We hence support scholarly calls (e.g., Kuratko, 2011) to further investigate this area, adopting sound theoretical foundations. On the other hand, the predominance of the theory of planned behavior of Ajzen (1991) supports the observations of Liñán et al. (2010) and Nabi et al. (2017) that entrepreneurial intentions are the single most used factor to study EE outcomes, as it is arguably a well-founded construct (Bae et al. 2014).

Across the identified technologies, gaming and simulation were the most popular in research as they have been witnessing a growing adoption in EE (Samašonok et al., 2020). We argue that their widespread impact stems from their ability to provide realistic entrepreneurial experiences (Belloti et al., 2014), through combining active participation in learning with enjoyable moments (Fonseca et al., 2014). They project a virtual environment that simulates real-life entrepreneurial scenarios (Dong & Tu, 2021; Hammoda, 2023; Grivokostopoulou et al., 2019). Students immersed in game-based environments learn through semi-factual hands-on experiences and then reflect on them to update their knowledge base and cognitive structures (Kolb & Kolb, 2005; Neck & Greene, 2011). Hence, they are regarded as key tools in experiential EE (Antonaci et al., 2015). As to online communities, we argue that their demonstrable impact is derived from their role in promoting entrepreneurial orientation, establishing mutual trust, a sense of belonging, peer support, knowledge sharing, and access to resources among participants along their learning journey (Kew & Tasir, 2021; Troise et al., 2021). They are also positioned as convenient mediums for today's mobile and remote learners (Wu & Song, 2019), as they are not limited by time, space, or social class (Autio et al., 2013).

Given the complexity and dynamism of entrepreneurship, the application of AI & ML in EE appears as a natural extension to their growing utilization in education as they help make sense of the exponentially growing knowledge (Winkler et al., 2023). They are also able to reach larger groups of students through personalized support (Ma et al., 2020). However, there is still a scarcity of research on their applications, which can be attributed to the technical intricacies and theoretical and methodological obscurities associated with their implementation (Ma et al., 2020). With regards to virtual and augmented realities, the literature showed that they can enhance learners' knowledge acquisition and synthesis by exposing them to various sensory stimuli (Radosavljevic et al., 2020), through experiential occurrences. Hence, they are most beneficial for developing practical entrepreneurial skills. Moreover, as modern virtual and augmented reality applications are delivered essentially through mobile devices, they can be conveniently utilized for EE environments both inside and outside the classroom (Papadakis et al., 2020).

The employment of multimedia and computer-assisted tools improves educational message clarity and communication, especially theory-laden content (O'Flaherty & Phillips, 2015). They are also rather convenient for students and easy to integrate with existing EE pedagogies (Liguori et al., 2021). On the other hand, MOOCs can improve the convenience and accessibility of education. However, they have a limited impact on developing social and communication skills, which are essential in entrepreneurship. This is a critical impasse in their adoption of EE. Developing EC is argued as the outcome educators should pursue when teaching entrepreneurship (Fayolle et al., 2006; Neergaard & Christensen, 2017).

5.1. Research and practical implications

Literature reviews in the entrepreneurship field provide important contributions that help progress theoretical foundations and practices and direct future research (Rauch, 2020). This review contributes to the limited validated knowledge at the nexus of technology, education, and competency development within an entrepreneurship context. It establishes a basic tool that maps the competencies developed by each potential technology when applied in EE.

Moreover, this study contributes to the long-standing arguments for adopting a competency-based approach in teaching and assessing entrepreneurship (Bird, 2019; Morris et al., 2013), by addressing an important challenge that Morris et al. (2013) highlighted, as its lack of a standard tool. Given the divergence in competency-based assessment methods, notwithstanding that the reliability and generalizability of any competency-based method is debatable (Bird, 2019), our approach provides a path that can guide scholars in implementing a more reliable measure. Moreover, we extend the applications of our reference tool; EntreComp framework (Bacigalupo et al., 2016) into a new pedagogical delivery method, i.e., educational technologies.

Entrepreneurship educators and program designers can utilize the developed mapping to better integrate technologies in their pedagogies, along with other teaching methods and tools. Hence, achieving better outcomes and improving students' learning experiences. Moreover, they can use it as a basic tool for assessing the effectiveness of applying ET in EE, following a competency-based approach. The mapping exercise can be replicated and adapted to assess the outcomes of other methods and tools used in EE and other business and management disciplines. The results of this study can also support educators and administrators' efforts in building the business case for adopting ET in entrepreneurship and business education, knowing that some of the main barriers to doing so are the lack of awareness of their possible applications and potential benefits (Cooper, 2007; Hammoda, 2024; Secundo et al., 2020).

5.2. Limitations

The correlation of a specific pedagogical intervention to learning outcomes is a complicated endeavor. As Young et al. (2003) argue, "*There is a multitude of instructional factors that produce a joint effect on learning, thereby limiting the usefulness of the reported effects of a specific instructional technology examined in isolation*". These factors can include technology quality (Limbu & Pham, 2023), compatibility and interoperability (Abbate et al., 2023), perceived safety and security (Borycki & Kushniruk, 2021), context, content and course structure, geographical location (Phan, 2023), student characteristics, including gender (Kusuma, 2023), among others. This is true for this study as well. In addition, the role of the teacher needs to be factored in when investigating the learning outcomes of ET in the EE context. The qualities of the entrepreneurship educator contribute to his ability to utilize the different teaching modalities, and thus influence message delivery and success (Oksanen et al., 2022).

Also, studies investigating new technologies typically lack the required methodological and theoretical rigorousness for journal publication (Béchard & Grégoire, 2005; Nabi et al., 2017). Hence, eliminating them might have reduced the number of results available for analysis. Additionally, our educational context is set to students at HEIs. Future research can look at studies outside universities, such as in incubators, enterprises,

and schools, as these are more adept at testing innovative pedagogical approaches in EE (Miles et al., 2017).

5.3. Future research

To build on this study and its results, we suggest a few areas that researchers can focus on 1) More empirical studies are needed to examine the effects of ET application in EE, especially for newer and more advanced technologies such as virtual worlds and artificial intelligence. 2) Researchers can use our mapping to conduct similar exercises that assess the competencies developed using other pedagogical tools in entrepreneurship and business courses. 3) Competency-based approach in EE outcomes assessment is rather subjective (Morris et al., 2013), and hence further studies validating the developed mapping tool are needed 4) Most importantly, research garnering the views of entrepreneurship educators, managers, and educational technology experts is required, given that the majority of the studies rely on students' feedback. These perspectives can provide valuable insights that help with ET adoption and their effective implementation.

6. Conclusion

Adopting a competency-based view of EE, this paper conducted a systematic literature review through an in-depth investigation of 26 articles. The reported learning outcomes were translated to entrepreneurial competencies and mapped against utilized technologies, relying on the EntreComp framework as a reference tool. We identified several groups of technologies that impacted the entrepreneurial competencies of students and reported on their effectiveness. The identified categories are simulation and gaming, AI and ML, online education, MOOCs, computer-assisted and multimedia software, virtual and augmented reality, and online communities. The study advanced scholarly understanding at the nexus of technology, education, and entrepreneurial competencies. It provides a basic map that can be applied to conduct similar outcome-assessment studies as well as aiding educators in integrating technologies into their entrepreneurship and management curricula. The study contributes to and advocates for a competency-based approach by providing a standard tool for its adoption. It also lowers the barriers to adopting ET in EE and business education more generally, by offering more clarity on their potential applications and benefits. In conclusion, we urge scholars to work closely with educators and practitioners to develop more comprehensive competency-based frameworks for EE, incorporating the findings of this review, to coalesce digital and non-digital methods for improved entrepreneurial learning outcomes.

Author Statement

The author declares that there is no conflict of interest.

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References

Abbate, S., Centobelli, P., Cerchione, R., Oropallo, E., & Riccio, E. (2023). Kick-start your scientific journey into the metaverse. *Knowledge Management & E-Learning, 15*(1), 103–114. https://doi.org/10.34105/j.kmel.2023.15.006

*Ahsan, M., & Faletehan, A. F. (2021). What do they like and dislike from game-based entrepreneurship learning? A qualitative study. *Jurnal Cakrawala Pendidikan, 40*(2), 495–507. https://doi.org/10.21831/cp.v40i2.38858

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

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

Autio, E., Dahlander, L., & Frederiksen, L. (2013). Information exposure, opportunity evaluation, and entrepreneurial action: An investigation of an online user community. *Academy of Management Journal, 56*(5), 1348–1371. https://doi.org/10.5465/amj.2010.0328

Bacigalupo, M., Kampylis, P., Punie, Y., & Van den Brande, G. (2016). *EntreComp: The entrepreneurship competency framework*. European Commission. Retrieved from https://eige.europa.eu/resources/lfna27939enn.pdf

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

*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. https://doi.org/10.1016/j.ijme.2018.02.006

Béchard, J. P., & Grégoire, D. (2005). Entrepreneurship education research revisited: The case of higher education. *Academy of management learning & education, 4*(1), 22–43. https://doi.org/10.5465/amle.2005.16132536

Bellotti, F., Berta, R., De Gloria, A., Lavagnino, E., Antonaci, A., Dagnino, F., ... 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

Bendermacher, G. W. G., oude Egbrink, M. G. A., Wolfhagen, I. H. A. P., & Dolmans, D. H. J. M. (2017). Unravelling quality culture in higher education: A realist review. *Higher Education, 73*, 39–60. https://doi.org/10.1007/s10734-015-9979-2

Bird, B. (2019). Toward a theory of entrepreneurial competency. In J. A. Katz & A. C. Corbet (Eds.), *Seminal Ideas for the Next Twenty-Five Years of Advances* (pp. 115–131). Emerald Publishing Limited. https://doi.org/10.1108/s1074-754020190000021011

Bonesso, S., Gerli, F., Pizzi, C., & Cortellazzo, L. (2018). Students' entrepreneurial intentions: The role of prior learning experiences and emotional, social, and cognitive competencies. *Journal of Small Business Management, 56*(S1), 215–242. https://doi.org/10.1111/jsbm.12399

Borycki, E. M., & Kushniruk, A. W. (2021). Editorial: Knowledge management and e-learning: Improving the safety of technologies and devices. *Knowledge Management & E-Learning, 13*(4), 390–394. https://doi.org/10.34105/j.kmel.2021.13.020

Chaudhary, A. G. (2008). Digital game-based learning – Future of education? *Pranjana: The Journal of Management Awareness, 11*(2). Retrieved from https://www.indianjournals.com/ijor.aspx?target=ijor:pr&volume=11&issue=2&article=001

*Chen, J., Chen, Y., Ou, R., Wang, J., & Chen, Q. (2022). How to use artificial intelligence to improve entrepreneurial attitude in business simulation games: Implications from a quasi-experiment. *Frontiers in Psychology, 13*: 856085. https://doi.org/10.3389/fpsyg.2022.856085

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

*Chen, Z., & Yu, X. (2020). Adoption of human personality development theory combined with deep neural network in entrepreneurship education of college students. *Frontiers in Psychology, 11*: 1346. https://doi.org/10.3389/fpsyg.2020.01346

*Cooper, B. (2007). Central issues in the use of computer-based materials for high volume entrepreneurship education. *Active Learning in Higher Education, 8*(3), 201–217. https://doi.org/10.1177/1469787407081887

*Dabbous, A., & Boustani, N. M. (2023). Digital explosion and entrepreneurship education: Impact on promoting entrepreneurial intention for business students. *Journal of Risk and Financial Management, 16*(1): 27. https://doi.org/10.3390/jrfm16010027

Denyer, D., & Tranfield, D. (2009). Producing a systematic review. In D. A. Buchanan & A. Bryman (Eds.), *The Sage Handbook of Organizational Research Methods* (pp. 671–689). Sage. Retrieved from https://psycnet.apa.org/record/2010-00924-039

*Dong, P., & Tu, C. C. (2021). Research on the impact of university innovation and entrepreneurship education on university students' entrepreneurship willingness based on virtual reality technology. *Mathematical Problems in Engineering, 2021*: 9730705. https://doi.org/10.1155/2021/9730705

Ellyton, F., E., Foli, F., Hammoda, B., Mallarge, J., Durst, S., & Rothenberger, S. (2022). *Reference framework for inclusive digital education*. Zenodo. https://doi.org/10.5281/zenodo.7215856

El Mawas, N., Trúchly, P., Podhradský, P., Medvecký, M., & Muntean, C. H. (2022). Impact of game-based learning on STEM learning and motivation: Two case studies in Europe. *Knowledge Management & E-Learning, 14*(4), 360–394. https://doi.org/10.34105/j.kmel.2022.14.020

European Commission. (2016). *A new skills agenda for Europe. Working together to strengthen human capital, employability and competitiveness*. European Commission. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016DC0381

Fayolle, A., Gailly, B., & Lassas-Clerc, N. (2006). Assessing the impact of entrepreneurship education programmes: A new methodology. *Journal of European Industrial Training, 30*(9), 701–720. https://doi.org/10.1108/03090590610715022

Fayolle, A. (2006). *International entrepreneurship education: Issues and newness*. Edward Elgar. https://doi.org/10.4337/9781847201652

Fayolle, A. (2013). Personal views on the future of entrepreneurship education. *Entrepreneurship & Regional Development, 25*(7/8), 692–701. https://doi.org/10.1080/08985626.2013.821318

Fellnhofer, K. (2019). Toward a taxonomy of entrepreneurship education research literature: A bibliometric mapping and visualization. *Educational Research Review, 27*, 28–55. https://doi.org/10.1016/j.edurev.2018.10.002

Ferreira, J. J., Fayolle, A., Ratten, V., & Raposo, M. (2018). *Entrepreneurial universities:*

Collaboration, education and policies. Edward Elgar. Retrieved from https://www.e-elgar.com/shop/gbp/entrepreneurial-universities-9781786432452.html

Fonseca, B., Gonçalves, R., Nunes, R. R., Teixeira, M. S., Paredes, H., Morgado, L., & Martins, P. (2014, June). BIZZY – A social game for entrepreneurship education. In *Proceedings of the International Conference on Learning and Collaboration Technologies (LCT 2014)* (pp. 33–41). Springer. https://doi.org/10.1007/978-3-319-07485-6_4

Gervais, J. (2016). The operational definition of competency-based education. *The Journal of Competency-Based Education, 1*(2), 98–106. https://doi.org/10.1002/cbe2.1011

Gianesini, G., Cubico, S., Favretto, G., & Leitão, J. (2018). Entrepreneurial competencies: Comparing and contrasting models and taxonomies. In S. Cubico, G. Favretto, J. Leitão & U. Cantner (Eds.), *Entrepreneurship and the Industry Life Cycle: The Changing Role of Human Capital and Competencies* (pp. 13–32). Springer.

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

Glackin, C. E., & Phelan, S. E. (2020). Improving entrepreneurial competencies in the classroom: An extension and in-study replication. *New England Journal of Entrepreneurship, 23*(2), 79–96. https://doi.org/10.1108/neje-04-2020-0005

*Grivokostopoulou, F., Kovas, K., & Perikos, I. (2019). Examining the impact of a gamified entrepreneurship education framework in higher education. *Sustainability, 11*(20): 5623. https://doi.org/10.3390/su11205623

Hammoda, B. (2023). Extracurricular activities for entrepreneurial learning: A typology based on learning theories. *Entrepreneurship Education and Pedagogy*. https://doi.org/10.1177/25151274231218212

Hammoda, B. & Foli, S. (2024). A digital competency framework for learners (DCFL): A conceptual framework for digital literacy. *Knowledge Management & E-Learning, 16*(3).

Hammoda, B. (2024a). ChatGPT for founding teams: An entrepreneurial pedagogical innovation. *International Journal of Technology in Education, 7*(1), 154–173. https://doi.org/10.46328/ijte.530

Hammoda, B. (2024b). Digital technology in entrepreneurship education: An overview of the status quo. In S. Durst & A. Pevkur (Eds.), *Digital Transformation for Entrepreneurship* (pp. 71–93). World Scientific. https://doi.org/10.1142/9789811270178_0006

Harden, R. M. (2002). Developments in outcome-based education. *Medical Teacher, 24*(2), 117–120. https://doi.org/10.1080/01421590220120669

*Huebscher, J., & Lendner, C. (2010). Effects of entrepreneurship simulation game seminars on entrepreneurs' and students' learning. *Journal of Small Business & Entrepreneurship, 23*(4), 543–554. https://doi.org/10.1080/08276331.2010.10593500

*Isabelle, D. A. (2020). Gamification of entrepreneurship education. *Decision Sciences Journal of Innovative Education, 18*(2), 203–223. https://doi.org/10.1111/dsji.12203

Januszewski, A., & Molenda, M. (2013). *Educational technology: A definition with commentary*. Routledge. https://doi.org/10.4324/9780203054000

Jesson, J., Matheson, L., & Lacey, F. M. (2011). *Doing your literature review: Traditional and systematic techniques*. Sage.

Jones, P., & Colwill, A. (2013). Entrepreneurship education: An evaluation of the Young Enterprise Wales Initiative. *Education + Training, 55*(8/9), 911–925.

https://doi.org/10.1108/et-04-2013-0052
*Kang, Y., & Lee, K. (2020). Designing technology entrepreneurship education using computational thinking. *Education and Information Technologies, 25*, 5357–5377. https://doi.org/10.1007/s10639-020-10231-2
Kasurinen, J., & Knutas, A. (2018). Publication trends in gamification: A systematic mapping study. *Computer Science Review, 27*, 33–44. https://doi.org/10.1016/j.cosrev.2017.10.003
Katz, J. A. (2003). The chronology and intellectual trajectory of American entrepreneurship education: 1876–1999. *Journal of business venturing, 18*(2), 283–300. https://doi.org/10.1016/s0883-9026(02)00098-8
Kew, S. N., & Tasir, Z. (2021). Analysing students' cognitive engagement in e-learning discussion forums through content analysis. *Knowledge Management & E-Learning, 13*(1), 39–57. https://doi.org/10.34105/j.kmel.2021.13.003
Klapper, R., & Tegtmeier, S. (2010). Innovating entrepreneurial pedagogy: Examples from France and Germany. *Journal of Small Business and Enterprise Development, 17*(4), 552–568. https://doi.org/10.1108/14626001011088723
Kolb, A. Y., & Kolb, D. A. (2005). Learning styles and learning spaces: Enhancing experiential learning in higher education. *Academy of Management Learning & Education, 4*(2), 193–212. https://doi.org/10.5465/amle.2005.17268566
*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
Kuratko, D. F. (2005). The emergence of entrepreneurship education: Development, trends, and challenges. *Entrepreneurship Theory and Practice, 29*(5), 577–597. https://doi.org/10.1111/j.1540-6520.2005.00099.x
Kuratko, D. F. (2011). Entrepreneurship theory, process, and practice in the 21st century. *International Journal of Entrepreneurship and Small Business, 13*(1), 8–17. https://doi.org/10.1504/ijesb.2011.040412
Kuratko, D. F., & Morris, M. H. (2018). Examining the future trajectory of entrepreneurship. *Journal of Small Business Management, 56*(1), 11–23. https://doi.org/10.1111/jsbm.12364
Kusuma, I. P. I. (2023). The role of gender in student teachers' technology integration in teaching English speaking skills during the Covid-19 pandemic. *Knowledge Management & E-Learning, 15*(3), 487–505. https://doi.org/10.34105/j.kmel.2023.15.028
Levy, Y., & Ellis, T. J. (2006). A systems approach to conduct an effective literature review in support of information systems research. *Informing Science, 9*, 181–212. https://doi.org/10.28945/479
Ligthelm, A. (2007). Survival analysis of small informal businesses in South Africa 2007-2010. *Eurasian Business Review, 1*, 160–179. https://doi.org/10.14208/bf03353804
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. https://doi.org/10.1108/jsbed-09-2020-0340
Limbu, Y. B., & Pham, L. (2023). Impact of e-learning service quality on student satisfaction during the Covid-19 pandemic: A systematic review. *Knowledge Management & E-Learning, 15*(4), 523–538. https://doi.org/10.34105/j.kmel.2023.15.030
Lin, J., & Sekiguchi, T. (2020, March). E-learning in entrepreneurship education: A systematic literature review. In *Proceedings of the 2020 IEEE International Conference*

on Teaching, Assessment, and Learning for Engineering (TALE) (pp. 83–90). IEEE. https://doi.org/10.1109/tale48869.2020.9368412

Liñán, F., Rodríguez-Cohard, J. C., & Rueda-Cantuche, J. M. (2010). Factors affecting entrepreneurial intention levels: A role for education. *International Entrepreneurship and Management Journal, 7*(2), 195–218. https://doi.org/10.1007/s11365-010-0154-z

Loi, M., & Fayolle, A. (2021). Impact of entrepreneurship education: A review of the past, overview of the present, and a glimpse of future trends. In C. H. Matthews & E. W. Liguori (Eds.), *Annals of Entrepreneurship Education and Pedagogy – 2021* (pp. 170–193). Edward Elgar. https://doi.org/10.4337/9781789904468.00018

López-Núñez, M. I., Rubio-Valdehita, S., Armuña, C., & Pérez-Urria, E. (2022). EntreComp questionnaire: A self-assessment tool for entrepreneurship competencies. *Sustainability, 14*(5): 2983. https://doi.org/10.3390/su14052983

*Lyons, R. M., Fox, G., & Stephens, S. (2023). Gamification to enhance engagement and higher order learning in entrepreneurial education. *Education + Training, 65*(3), 416–432. https://doi.org/10.1108/et-05-2022-0204

Massaro, M., Dumay, J., & Guthrie, J. (2016). On the shoulders of giants: Undertaking a structured literature review in accounting. *Accounting, Auditing & Accountability Journal, 29*(5), 767–801. https://doi.org/10.1108/aaaj-01-2015-1939

*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. https://doi.org/10.37394/232015.2020.16.75

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*: 551389. https://doi.org/10.3389/fpsyg.2020.551389

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, 59*(7/8), 811–824. https://doi.org/10.1108/et-01-2017-0007

Mishra, D., Gunasekaran, A., Papadopoulos, T., & Hazen, B. (2017). Green supply chain performance measures: A review and bibliometric analysis. *Sustainable Production and Consumption, 10*, 85–99. https://doi.org/10.1016/j.spc.2017.01.003

Mojica, M. N., Gebremedhin, T. J., & Schaeffer, P. V. (2010). A county-level assessment of entrepreneurship and economic development in Appalachia using simultaneous equations. *Journal of Developmental Entrepreneurship, 15*, 3–18. https://doi.org/10.1142/s1084946710001452

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

Morselli, D., & Gorenc, J. (2022). Using the EntreComp framework to evaluate two entrepreneurship education courses based on the Korda Method. *The International Journal of Management Education, 20*(1): 100591. https://doi.org/10.1016/j.ijme.2021.100591

Mwasalwiba, E. S. (2010). Entrepreneurship education: A review of its objectives, teaching methods, and impact indicators. *Education + Training, 52*(1), 20–47. https://doi.org/10.1108/00400911011017663

Nabi, G., Linan, F., & Fayolle, A. (2017). The impact of entrepreneurship education in higher education: A systematic review and research agenda. *Academy of Management Learning & Education, 16*(2), 277–300. https://doi.org/10.5465/amle.2015.0026

Neck, H. M., & Greene, P. G. (2011). Entrepreneurship education: Known worlds and new

frontiers. *Journal of Small Business Management, 49*(1), 55–71. https://doi.org/10.1111/j.1540-627x.2010.00314.x

Neergaard, H., & Christensen, D. R. (2017). Breaking the waves: Routines and rituals in entrepreneurship education. *Industry and Higher Education, 31*(2), 90–100. https://doi.org/10.1177/0950422217692479

Neuendorf, K. A. (2018). Content analysis and thematic analysis. In P. Brough (Ed.), *Advanced Research Methods for Applied Psychology* (pp. 211–223). Routledge.

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

Nixon, E., Scullion, R., & Hearn, R. (2018). Her majesty the student: Marketised higher education and the narcissistic (dis)satisfactions of the student-consumer. *Studies in Higher Education, 43*(6), 927–943. https://doi.org/10.1080/03075079.2016.1196353

Oksanen, L., Oikkonen, E., & Pihkala, T. (2022). Adopting entrepreneurship education – Teachers' professional development. *Entrepreneurship Education and Pedagogy, 6*(2), 276–298. https://doi.org/10.1177/25151274221091698

*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. https://doi.org/10.1177/09504222221121283

Oyelere, S. S., Suhonen, J., Shonola, S. A., & Joy, M. S. (2016, October). Discovering students mobile learning experiences in higher education in Nigeria. In *Proceedings of the 2016 IEEE Frontiers in Education Conference (FIE)* (pp. 1–7). IEEE. https://doi.org/10.1109/fie.2016.7757541

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

Pacheco, D. F., Dean, T. J., & Payne, D. S. (2010). Escaping the green prison: Entrepreneurship and the creation of opportunities for sustainable development. *Journal of Business Venturing, 25*(5), 464–480. https://doi.org/10.1016/j.jbusvent.2009.07.006

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2017). Designing and creating an educational app rubric for preschool teachers. *Education and Information Technologies, 22*(6), 3147–3165. https://doi.org/10.1007/s10639-017-9579-0

Papadakis, S., Vaiopoulou, J., Kalogiannakis, M., & Stamovlasis, D. (2020). Developing and exploring an evaluation tool for educational apps (ETEA) targeting kindergarten children. *Sustainability, 12*(10): 4201. https://doi.org/10.3390/su12104201

*Park, S., & Kim, S. (2023). The avaritia: Entrepreneurship practice to understand the problem of information control through gamification. *Sustainability, 15*(8): 6738. https://doi.org/10.3390/su15086738

Petticrew, M., & Roberts, H. (2006). *Systematic reviews in the social sciences: A practical guide*. John Wiley & Sons. https://doi.org/10.1002/9780470754887

Phan, N. T. T. (2023). Self-efficacy in a MOOC environment: A comparative study of engineering students in Taiwan and Vietnam. *Knowledge Management & E-Learning, 15*(1), 64–84. https://doi.org/10.34105/j.kmel.2023.15.004

Pittaway, L., & Cope, J. (2007). Entrepreneurship education: A systematic review of the evidence. *International Small Business Journal, 25*(5), 479–510. https://doi.org/10.1177/0266242607080656

Ploum, L., Blok, V., Lans, T., & Omta, O. (2018). Toward a validated competency framework for sustainable entrepreneurship. *Organization & Environment, 31*(2), 113–

132. https://doi.org/10.1177/1086026617697039
Podsakoff, P. M., MacKenzie, S. B., Bachrach, D. G., & Podsakoff, N. P. (2005). The influence of management journals in the 1980s and 1990s. *Strategic Management Journal, 26*(5), 473–488. https://doi.org/10.1002/smj.454
*Pratikto, H., Hanafiya, R., Ashar, M., Akbar, M. I., & Harsono, Y. T. (2021). Entrepreneurship game apps to enhancement student skill thinking analytic in class online. *International Journal of Interactive Mobile Technologies, 15*(8), 155–162. https://doi.org/10.3991/ijim.v15i08.21575
Qureshi, M. I., Khan, N., Raza, H., Imran, A., & Ismail, F. (2021). Digital technologies in education 4.0. Does it enhance the effectiveness of learning? A Systematic literature review. *International Journal of Interactive Mobile Technologies, 15*(4), 31–47. https://doi.org/10.3991/ijim.v15i04.20291
Radosavljevic, S., Radosavljevic, V., & Grgurovic, B. (2020). The potential of implementing augmented reality into vocational higher education through mobile learning. *Interactive Learning Environments, 28*(4), 404–418. https://doi.org/10.1080/10494820.2018.1528286
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): 5344. https://doi.org/10.3390/su11195343
Ratten, V., & Jones, P. (2021). Covid-19 and entrepreneurship education: Implications for advancing research and practice. *The International Journal of Management Education, 19*(1): 100433. https://doi.org/10.1016/j.ijme.2020.100432
Ratten, V., & Jones, P. (2023). Generative artificial intelligence (ChatGPT): Implications for management educators. *The International Journal of Management Education, 21*(3): 100857. https://doi.org/10.1016/j.ijme.2023.100857
Ratten, V., & Usmanij, P. (2021). Entrepreneurship education: Time for a change in research direction? *The International Journal of Management Education, 19*(1): 100368. https://doi.org/10.1016/j.ijme.2020.100367
Rauch, A. (2020). Opportunities and threats in reviewing entrepreneurship theory and practice. *Entrepreneurship Theory and Practice, 44*(5), 847–860. https://doi.org/10.1177/1042258719879635
Rew, D. A. (2020). The development of high impact national and regional journals in medicine and the health sciences. *Science Editor and Publisher, 5*(2), 113–122. https://doi.org/10.24069/2542-0267-2020-2-113-122
Rideout, E. C., & Gray, D. O. (2013). Does entrepreneurship education really work? A review and methodological critique of the empirical literature on the effects of university-based entrepreneurship education. *Journal of Small Business Management, 51*(3), 329–351. https://doi.org/10.1111/jsbm.12021
*Samašonok, K., Išoraitė, M., & Žirnelė, L. (2020). Education of entrepreneurship by participation in a business simulation enterprise activities: Conditions of effectiveness and opportunities for improvement. *Entrepreneurship and Sustainability Issues, 7*(4): 3122–3144. https://doi.org/10.9770/jesi.2020.7.4(36)
Schou, P. K., Bucher, E., & Waldkirch, M. (2022). Entrepreneurial learning in online communities. *Small Business Economics, 58*(4), 2087–2108. https://doi.org/10.1007/s11187-021-00502-8
Secundo, G., Del Vecchio, P., & Mele, G. (2020). Social media for entrepreneurship: Myth or reality? A structured literature review and a future research agenda. *International Journal of Entrepreneurial Behavior & Research, 27*(1), 149–177. https://doi.org/10.1108/ijebr-07-2020-0453

Sirelkhatim, F., & Gangi, Y. (2015). Entrepreneurship education: A systematic literature review of curricula contents and teaching methods. *Cogent Business & Management, 2*(1): 1052034. https://doi.org/10.1080/23311975.2015.1052034

Sousa, M. J., Carmo, M., Gonçalves, A. C., Cruz, R., & Martins, J. M. (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, 94*, 227–240. https://doi.org/10.1016/j.jbusres.2018.02.005

Thelwall, M. (2018). Dimensions: A competitor to Scopus and the Web of Science? *Journal of Informetrics, 12*(2), 430–435. https://doi.org/10.1016/j.joi.2018.03.006

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management, 14*, 207–222. https://doi.org/10.1111/1467-8551.00375

Tranfield, D., Denyer, D., Marcos, J., & Burr, M. (2004). Co-producing management knowledge. *Management Decision, 42*(3/4), 375–386. https://doi.org/10.1108/00251740410518895

Tretyakova, N., Lyzhin, A., Chubarkova, E., Uandykova, M., & Lukiyanova, M. (2021). Mobile-learning platform for the development of entrepreneurial competencies of the students. *International Journal of Interactive Mobile Technologies, 15*(9), 118–135. https://doi.org/10.3991/ijim.v15i09.20225

Troise, C., Dana, L. P., Tani, M., & Lee, K. Y. (2022). Social media and entrepreneurship: Exploring the impact of social media use of start-ups on their entrepreneurial orientation and opportunities. *Journal of Small Business and Enterprise Development, 29*(1), 47–73. https://doi.org/10.1108/jsbed-01-2021-0041

Vestergaard, L., Moberg, K., & Jørgensen, C. (2012). *Impact of entrepreneurship education in Denmark - 2011*. Fonden for Entreprenørskab – Young Enterprise Denmark. Retrieved from https://www.yumpu.com/en/document/view/26460251/impact-of-entrepreneurship-education-in-denmark-2011

*Vorbach, S., Poandl, E. M., & 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

Waltman, L. (2016). A review of the literature on citation impact indicators. *Journal of Informetrics, 10*(2), 365–391. https://doi.org/10.1016/j.joi.2016.02.007

*Widjaja, S. U. M., Wibowo, A., Narmaditya, B. S., Wardoyo, C., & Saptono, A. (2022). Identifying factors affecting entrepreneurship education and entrepreneurial intention among Indonesian university students. *Entrepreneurial Business and Economics Review, 10*(3), 89–104. https://doi.org/10.15678/eber.2022.100306

Winkler, C., Hammoda, B., Noyes, E., & Van Gelderen, M. (2023). Entrepreneurship education at the dawn of generative artificial intelligence. *Entrepreneurship Education and Pedagogy, 6*(4), 579–589. https://doi.org/10.1177/25151274231198799

Winter, M., & Hammoda, B. (2024). Digital skills platform from Silicon Valley: Training new generations using experiential learning principles. In B. Hammoda & S. Durst (Eds.), *Contemporary Entrepreneurship: Global Perspectives and Cases*. Routledge. https://doi.org/10.4324/9781003371403-7

*Wu, W. H., Kao, H. Y., Wu, S. H., & Wei, C. W. (2019). Development and evaluation of affective domain using student's feedback in entrepreneurial massive open online courses. *Frontiers in Psychology, 10*: 1109. https://doi.org/10.3389/fpsyg.2019.01109

*Wu, Y., & Song, D. (2019). Gratifications for social media use in entrepreneurship courses: Learners' perspective. *Frontiers in Psychology, 10*: 1270. https://doi.org/10.3389/fpsyg.2019.01270

*Wu, Y. J., Yuan, C. H., & Pan, C. I. (2018). Entrepreneurship education: An experimental study with information and communication technology. *Sustainability, 10*(3): 691. https://doi.org/10.3390/su10030691

*Yang, Q., Zhang, Y., & Lin, Y. (2022). Study on the influence mechanism of virtual simulation game learning experience on student engagement and entrepreneurial skill development. *Frontiers in Psychology, 12*: 772157. https://doi.org/10.3389/fpsyg.2021.772157

Young, M. R., Klemz, B. R., & Murphy, J. W. (2003). Enhancing learning outcomes: The effects of instructional technology, learning styles, instructional methods, and student behavior. *Journal of Marketing Education, 25*(2), 130–142. https://doi.org/10.1177/0273475303254004

Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational Research Review, 30*: 100326. https://doi.org/10.1016/j.edurev.2020.100326

*Zuo, L., Shestak, V., Vlasova, S., & Islamov, A. (2021). Efficiency of outsourcing and outstaffing mechanisms based on MOOCs in the market of entrepreneurial education services. *International Journal of Emerging Technologies in Learning, 16*(2), 135–148. https://doi.org/10.3991/ijet.v16i02.18821