ORIGINAL PAPER

Entrepreneurship education in the era of generative artificial intelligence

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Abstract

Generative artificial intelligence has seen fast paced developments, with it being utilised in numerous contexts, including both entrepreneurship and education. This has led to calls to integrate generative artificial intelligence into entrepreneurship education, to help prepare students to take advantage of future entrepreneurial opportunities. The technology also has the potential to influence pedagogy, teaching practice, and assessment and has raised concerns and questions within education about how educators can train students to use the latest technology to prepare them for the future, whilst managing potential changes to teaching practice. However, given the rapid emergence of the technology, discussion as to the implications for education and particularly entrepreneurship education is limited and there have been calls for further exploration and discussion. This paper addresses these calls by discussing some of the potential implications which generative artificial intelligence brings to entrepreneurship education and the entrepreneurship classroom, at both a macro and curricular level. The advancement of generative artificial intelligence furthers the need for entrepreneurship educators to embrace the technology in a managed way, develop students critical and reflective thinking, and foster the development and assessment of practical and technical entrepreneurial skills, to support student's effective utilisation of generative artificial intelligence. Educators should also be aware of the potential effects which generative artificial intelligence poses to teaching and assessment.

Keywords Generative artificial intelligence · Artificial intelligence · Technology · Entrepreneurship education · Business education · Industry 4.0

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Introduction

Entrepreneurship education is becoming increasingly established and prominent in both developed and developing countries worldwide. This proliferation of entrepreneurship education has been supported by governments and policy makers believing it can serve as a catalyst for economic growth and development. Entrepreneurship and innovation have been advocated as essential contributors to long-term sustainable economic growth and development (Singer et al., 2015) and thus a generator of prosperity and competitiveness (European Commission [EC], 2012; Martinez et al., 2010). Entrepreneurship has also been posited in bringing a range of benefits to society including generating employment, supporting employability, and innovation (Bell, 2016; Greene & Saridakis, 2008). Previous research has found that entrepreneurship education can support entrepreneurship and innovation through developing entrepreneurial skills and competencies (Bell, 2015) and entrepreneurial attitudes, behaviours, and mindsets (Cui et al., 2021). This can prepare future entrepreneurs, or intrapreneurs, by providing the required knowledge and skills to start, develop, and grow a successful business. The potential of entrepreneurship education to effectively prepare students for both employment and entrepreneurship (Hyams-Ssekasi & Caldwell, 2018), extends the relevance of entrepreneurship education to all students rather than only those currently with entrepreneurial ideas (Bell and Bell, 2016; O'Brien et al., 2019). This has led to entrepreneurship education being promoted and delivered more broadly throughout the world (Crammond, 2020).

To support entrepreneurship and employability, entrepreneurship education should prepare students for job roles which do not currently exist, through engaging students in cutting edge and innovative technology and preparing them for the future (QAA, 2018). The fourth industrial revolution (industry 4.0) is leading to a transition of existing and new occupations and future entrepreneurs need the skills to embrace advanced technology (Tatpuje et al., 2022). Through the incorporation of new technology and e-commerce, the fourth industrial revolution has the potential to restructure markets and create new opportunities for entrepreneurs (Hassan et al., 2020). The World Economic Forum forecasts that 70% of new businesses will involve digital platforms and businesses modules (WEF, 2021), and therefore many business opportunities will require future entrepreneurs to have the digital skills and understanding of new technology. However, Tatpuje et al. (2022) found that students were often not prepared with the requisite skills for digital entrepreneurship. This is underlined by Wahl and Münch (2022) who suggested that most entrepreneurship programmes focus on general entrepreneurial principles rather than providing students with the digital and technological skills required to take advantage of the many opportunities within industry 4.0. To effectively prepare students for future entrepreneurial endeavours, entrepreneurship education should prepare students to take advantage of new opportunities, through embracing technology (Bell, 2023).

One emerging tool and technology that has been identified as having the greatest potential to assist entrepreneurs is generative artificial intelligence, such as

ChatGPT (Short & Short, 2023). It has been proposed that it has the potential to augment and replace tasks associated with idea production, selling, scaling, content creation and communication (Chalmers et al., 2021; Short & Short, 2023). The application of such tools has the potential to amplify entrepreneurs' creativity and imaginativeness and open new opportunities (Townsend & Hunt, 2019) and can assist entrepreneurs in making better decisions as a result of greater data and informed reasoning (Korzynski et al., 2023). Thus, making generative artificial intelligence a valuable tool for future entrepreneurs.

The advent and development of generative artificial intelligence also offer transformative potential in the field of education by opening opportunity for pedagogical innovation (Cooper, 2023). However, the advancement of generative artificial intelligence must be weighed against the challenges and implications that this technology presents (Short & Short, 2023). Whilst it is an important emerging tool for entrepreneurs and offers opportunities in the classroom, it has been highlighted as having implications for teaching and assessing students (Peres et al., 2023). Concerns have been raised as to how original work developed by students and artificially generated work can be distinguished, due to a lack of plagiarism detected (Gao et al., 2022). This has led to questions as to how educators can train and prepare students for future jobs, by being knowledgeable and able to apply the latest technology, whilst dealing with the disruption of the status quo in the classroom, which such technology can bring (Peres et al., 2023). Whilst discussion of generative artificial intelligence is still at an early stage in education (Cooper, 2023), there are calls for educators to explore its effective use and implications (Pavlik, 2023). This paper discusses some of the potential implications which generative artificial intelligence brings to entrepreneurship education and the entrepreneurship classroom. This paper addresses calls for both more discussion and investigation of generative artificial intelligence in the classroom context to support entrepreneurship (Short & Short, 2023), and for preparing students for industry 4.0 by integrating new technologies into the entrepreneurship education curriculum (Wahl & Münch, 2022).

The next section provides an overview of generative artificial intelligence and some of the current leading players in the market. Then the implications of generative artificial intelligence on different forms of entrepreneurship education is considered, followed by a discussion of the considerations and implications for entrepreneurship education at the curricular level. Finally, a conclusion is presented which summarises the influence and implications that generative artificial intelligence brings to entrepreneurship education and details avenues for future research.

Generative artificial intelligence

Artificial intelligence has seen rapid development and growth in its application, as it is able to undertake tasks previously performed by intelligent beings, such as learning, judgement, and decision making (Xu et al., 2021). Artificial intelligence has been proved to be effective in solving complicated problems in a variety of fields, including business (Kraus et al., 2020; Obschonka & Audretsch, 2020), entrepreneurship (Short & Short, 2023), and education (Ouyang et al., 2022). Generative

artificial intelligence is a type of artificial intelligence which can generate new content, including text, images, and sound and music, based on directed input (Pavlik, 2023). This is achieved through a generative machine learning model which is trained on a large pool of data and then can produce new realistic examples from the data which it holds and has been trained on (Pavlik, 2023). This application of artificial intelligence has led to the development of intelligent chatbots and virtual assistants that can interpret, understand, and produce human language based on user requests (Caldarini et al., 2022). The accessibility of generative artificial intelligence to a wider and non-specialist audience is bringing forward an era of potential transformation in the classroom (Pavlik, 2023).

Numerous generative artificial intelligence platforms have been developed targeting different markets and with different specialisms, including Bard (Google), ERNIE (Baidu), Tongyi Qianwen (Alibaba), Stable Diffusion (Stability AI), to name a few. Currently one of the most discussed and powerful generative artificial intelligence platforms is ChatGPT (Farrokhnia et al., 2023; Korzynski et al., 2023). ChatGPT can generate human-like text through natural language processing based on user's requests and questions (Tlili et al., 2023). This has the potential to facilitate learning by asking questions and reflecting on the responses, which is at the centre of the interactive learning process (Rospigliosi, 2023). This creates a sustained dialogue with direct responses, which is different to the experience provided by traditional search engines, leading to many questions and discussion within educational contexts (Rospigliosi, 2023). Despite the many possible uses and benefits of generative artificial intelligence, its fast paced development has sparked debate about its potential risks and implications for education (Farrokhnia et al., 2023). Despite some advocating the benefits which it can bring to the classroom, through delivering adaptive and personalised learning opportunities (Qadir, 2022), concerns have been raised about the potential adverse impact on assessment and academic integrity (Cotton et al., 2023; Rudolph et al., 2023). Additional concerns have been raised about the potential impact on the development of students' higher-order thinking skills (Farrokhnia et al., 2023; Susnjak, 2022), and the ethical concerns (Mhlanga, 2023). One significant shortcoming of generative models is that, while they excel at mimicking content and style, they cannot learn and understand meaning, therefore can potentially generate inaccurate and damaging output (Bender & Koller, 2020; Liang et al., 2022).

It has been highlighted that debate and discussion is commonplace when innovative technology emerges which disrupts traditional educational practice, as it requires educators to review and adapt their teaching (Qadir, 2022). Despite calls for further integration and the adoption of generative artificial intelligence into curricular, academic debate in this regard is still at the early stages (Cooper, 2023), and educators are still yet to maximise the potential of artificial intelligence in teaching and learning environments (Celik, 2023). Furthermore, there is currently very limited debate as to the potential implications of generative artificial intelligence in entrepreneurship education. Since entrepreneurship education is not a monolith and can take many forms based on the objectives it seeks to achieve, the next section will consider some of the potential implications that generative artificial intelligence brings to different types of entrepreneurship education.

The implications of generative artificial intelligence for different forms of entrepreneurship education

Entrepreneurship education has been recognised as consisting of a diverse set of educational goals and objectives (Bell, 2021), which stem from being grounded within conflicting views as to the purpose and value of entrepreneurship education (Hannon, 2006). This has led to entrepreneurship education being identified as taking several forms depending on its goals and objectives. This has led to distinctions being made between education 'about', 'for', and 'through' entrepreneurship (Pittaway & Edwards, 2012: QAA, 2018). The three types of entrepreneurship education offer different benefits for the learner through distinct learning experiences. This classification distinguishes the goal of the learning, which in turn influences the pedagogic approach to teaching and its assessment (Biggs, 1996). Knowledge, skills, and experience have all been found to support entrepreneurial learning and entrepreneurship (Bell & Bell, 2020) and 'about', 'for', and 'through' entrepreneurship education places emphasis differently on developing these areas.

Education 'about' entrepreneurship aims to equip students with a comprehensive understanding of the theory and knowledge that form the foundation of entrepreneurship (Kakouris & Liargovas, 2021). It is arguably teaching 'about' entrepreneurship which could be most affected by generative artificial intelligence, as the main strength of generative artificial intelligence is generating and presenting information (Pavlik, 2023), which is commonly the role of the teacher in teaching 'about' entrepreneurship (Bell & Bell, 2020). This has the potential to lead to concerns where educators are used to playing a leading role in the transmission and delivery of knowledge in which they are perceived as experts, as there is a danger that their perception as experts could be undermined by students' access to generative artificial intelligence. This has the potential to erode the perceived value and role of the educator as an effective purveyor of knowledge. However, generative artificial intelligence has the potential to support learning by allowing students to ask questions and reflect, challenge, and discuss answers when integrated into the curriculum, which can increase engagement and interaction with knowledge (Rospigliosi, 2023). Further possibilities exist for students to utilise generative artificial intelligence to find examples of the concepts being taught, where they can apply their knowledge and demonstrate their understanding within a classroom setting. Teaching 'about' entrepreneurship is commonly graded and evaluated by assessing students' knowledge and understating of key entrepreneurship concepts and theories. Generative artificial intelligence has been presented as posing challenges to transitional course work, as it can be used to provide robust answers to specific topics, raising concerns about academic integrity of written assignments and essays (Cotton et al., 2023; Rudolph et al., 2023). To mitigate these concerns some educators might choose to return to exams, although there are potentially other ways in which knowledge and understanding can be assessed whilst also developing and demonstrating skills relevant for entrepreneurship. In line with the recommendations of Rudolph et al. (2023), methods appropriate for

the entrepreneurship classroom could include time restricted in class case studies, where students demonstrate the ability to work under pressure; live case studies where local entrepreneurs present specific problems and challenges which cannot be readily found on the internet and engages students' application, listening, and questioning skills; presentations, which showcase students presentation skills; the development of assets such as websites and flyers, developing students communication skills; or by setting assignments where the students voice can come through, for example, explaining why a particular innovation or entrepreneur interests them. Such assessments have the potential to start to blur towards teaching 'for' entrepreneurship.

The teaching 'for' entrepreneurship approach aims to prepare students for possible entrepreneurial endeavours by developing their entrepreneurial skills and competencies. This gives students an understanding of what it means to be entrepreneurial and builds the requisite practical skills and competences for entrepreneurship (Hannon, 2005). To support the development of practical skills and competences, instruction typically shifts away from traditional didactic teaching approaches towards engaging students in activities and experiences that allow them to build their enterprising and entrepreneurial skills and competencies. With generative artificial intelligence being increasingly used to support and augment tasks in business and entrepreneurship (van Dun et al., 2023), allowing and encouraging students to use such technology within the entrepreneurship curricular to develop competency in their application is becoming increasingly important for preparing students for the future (Wahl & Münch, 2022). Generative artificial intelligence can potentially be worked into the entrepreneurship curricula by allowing students to explore how it can support entrepreneurial processes such as idea development, decision making, and communication. For example, it can be used in the classroom to develop and/or rephrase content, and presentations (Short & Short, 2023), providing students the opportunity to review and analyse outputs to determine potential improvements. Such reflection is at the heart of interactive learning (Rospigliosi, 2023) and entrepreneurial learning (Bell & Bell, 2020). There is also the potential for generative artificial intelligence to be worked into numerous classroom activities, such as reviewing business models and plans, analysing effective marketing campaigns, and analysing market data. Generative artificial intelligence can also be built into assessment, which looks to assess student's practical entrepreneurial skills and competences, to see how well they can use and embrace the technology as part of entrepreneurial tasks, including identifying when and where it can be used effectively. This can be assessed through entrepreneurial activities where students are given a limited time to develop an output or series of assets. Examples might include developing a minimum viable product, where students identify the problem they are trying to solve and develop an explainer video and/or a landing page for a proposed product or service (Winkel et al., 2020), or undertaking hackathons where students work with industry to apply their knowledge to complete set challenges (Eimler & Straßmann, 2023). Such activities allow students to discover and experience facets of entrepreneurship whilst developing and demonstrating both hard and soft skills (Eimler & Straßmann, 2023). Activities can potentially be assessed both in terms of the outputs, but also by reflections on the process (Bell, 2022).

Education 'through' entrepreneurship supports students to develop entrepreneurial capabilities through experiencing and practicing entrepreneurship (Hannon, 2005). This provides the opportunity for students to put their knowledge and skills into real practice, allowing for the transformation of knowledge through experience (Bell & Bell, 2020; Kakouris & Liargovas, 2021). This situates learning in practice and provides students with a more authentic experience of entrepreneurship (Balan & Metcalfe, 2012; Bell & Cui, 2023). Learning 'through' entrepreneurship builds on learning 'for' entrepreneurship, although it involves engagement with real entrepreneurial practice, rather than engaging in only some facets of entrepreneurship, which is often the case with learning 'for' entrepreneurship. This means that many of the potential applications of generative artificial intelligence within a teaching 'for' entrepreneurship approach, are likely to still be relevant when teaching 'through' entrepreneurship, but there is the opportunity to extend their use further into actual practice. Generative artificial intelligence can be utilised by students to initiate and run a business within venture creation programmes, which support and scaffold students launching a business (Bozward & Rogers-Draycott, 2020). Learning can also be achieved by not only reflecting on outputs generated by artificial intelligence but also by getting feedback from actual customers, which is an essential part of the entrepreneurial journey and increasingly important in new ventures (Liu & Bell, 2019). This offers the opportunity for students to understand how, and when, generative artificial intelligence can be effectively utilised and how it can be built into entrepreneurship and business processes, which is key to understanding and enabling effective artificial intelligence use (van Dun et al., 2023). Learning from feedback and the ability to reflect on one's actions and use of tools and technology enables continuous learning from practical action and experience (Schön, 1983). Learning within the 'through' entrepreneurship approach is commonly assessed through both students' entrepreneurial endeavours and reflections of the entrepreneurial process. Such reflections could be extended to reflect on how effective generative artificial intelligence is in practice, including its use and shortcomings within the entrepreneurial process.

Having considered some of the potential implications of generative artificial intelligence for different forms of entrepreneurship education, teaching 'about', 'for', and 'through' entrepreneurship education, the next section explores considerations which generative artificial intelligence brings at a curricular level.

Considerations for developing entrepreneurship education curricular in the era of generative artificial intelligence

Generative artificial intelligence has the potential to bring many benefits to entrepreneurship education at the curricular level, as it has the potential to enhance students' learning, increase engagement, and improve the learning experience (Dwivedi et al., 2023; Okonkwo & Ade-Ibijola, 2021). In addition, learning about the application of artificial intelligence has the potential to support future employment (Centre for Teaching and Learning, 2023) and engagement in entrepreneurship (Wahl & Münch, 2022). However, generative artificial intelligence also introduces new considerations

for entrepreneurship educators when developing programmes and curricular, which have largely not been explored within the literature. Some potential considerations are now proposed and discussed.

Embracing generative artificial intelligence in a managed way in the entrepreneurship education classroom

There is a need to embrace new technology in the classroom and curricular, to ensure that students are ready for future opportunities. Technology continues to open access to markets and create new markets, meaning that it is important for students to understand the latest technology, such as generative artificial intelligence, to be able to take advantage of those new opportunities. Therefore, entrepreneurship educators should find ways of bringing artificial intelligence into the classroom. To achieve this, educators will need to keep up to date with technological developments and innovations, so that they can introduce them into the classroom, to allow students to explore, experiment with, and learn about the new technology (Bell, 2023; Wahl & Münch, 2022). This might increasingly involve embedding and merging entrepreneurship with more technical fields, rather than teaching generic entrepreneurial concepts in isolation (Wahl & Münch, 2022).

Integrating generative artificial intelligence into the classroom can also bring pedagogic benefits. It can facilitate and support a more personalised learning experience, by providing answers, feedback, and outputs based on the relevant needs of the student (Farrokhnia et al., 2023). Given that entrepreneurship is a diverse and eclectic field, with no single best opportunity and approach, and it is often not feasible for the educator to discuss all industries and innovations, students likley need to lead the way in terms of their exploration of opportunities based on their own interests and skills. In such a scenario personalised support and learning is particularly valuable. Previous research has also found that generative artificial intelligence can support the development of complex learning (Jia et al., 2021). This can be achieved through tutoring and guiding learners' stage by stage through complex tasks by providing customised instruction and feedback (Biswas, 2023). This could be particularly valuable in the entrepreneurship education context, given that students regularly must engage with complex tasks which might be outside their major, or main area of study, such as accounting, computerised design, or basic coding or programming, as part of an entrepreneurship education module.

Despite the benefits which generative artificial intelligence can bring to the classroom, both in terms of preparing students for the future and supporting their learning, some have been hesitant to embrace it. Indeed, opposing viewpoints have emerged as to whether generative artificial intelligence will advance, or damage education (Lim et al., 2023). For example, some bodies such as the New York City Department of Education have sought to ban ChatGPT; however, it is unclear whether such actions will reduce potential academic misconduct (Eliot, 2023), and might leave students ill prepared for future employment and entrepreneurship. Longer term repercussions have also been posited, if students seek to sidestep reading and learning about a topic in depth, in favour of defaulting to using generative

artificial intelligence to achieve a surface level understanding of the topic (Dwivedi et al., 2023). Whilst it might be possible to limit its use in the short term, it seems inevitable that eventually it will work its way into the everyday aspects of life, including education (Short & Short, 2023). Therefore, trying to actively embrace it early on and explore the educational possibilities to support students seems logical. Embracing generative artificial intelligence will require a balanced approach as educators will need to promote the application, benefits, and value of the technology, whilst also highlighting its many potential shortcomings and potential to generate inaccurate and incorrect output (Bender & Koller, 2020; Liang et al., 2022). This will likely only increase the need for critical and reflective graduates.

Developing critical and reflective thinkers in the era of generative artificial intelligence

Whilst generative artificial intelligence can increase and improve access to information (Farrokhnia et al., 2023), students are increasingly going to need critical thinking skills to be able to assess, review, and interpret the information provided. Furthermore, critical thinking is an important tool for effective enquiry (Facione, 1990) and is regularly utilised in the entrepreneurial process to assess opportunities, analyse data, and chart paths of action. However, traditionally critical thinking has been underemphasised in business and entrepreneurship education (Örtenblad et al., 2013). There is currently debate as to whether artificial intelligence can support or limit students' development of critical thinking. For example, Cotton et al. (2023) found that generative artificial intelligence programmes have the potential to stimulate students critical thinking by responding to a set of questions personalised for each student. It has been proposed that intelligent conversation with artificial intelligence offers a valuable opportunity to augment complex learning in a scaffolded and low-stakes manner (Bayat et al., 2022). However, critics have suggested that artificial intelligence has the potential to lead to surface level learning, with limited depth and criticality (Dwivedi et al., 2023). The way in which generative artificial intelligence is utilised in learning is likely to play a part in how effective it is at developing students critical thinking. If only introduced as a tool to produce knowledge, it is likely to limit the development of critical thinking skills; however, if outputs are reviewed, interrogated, and reflected upon, supporting students to create their own meaning and understanding, more critical thought and critical skills are likely to be developed. It is important for students to understand that whilst artificial intelligence might appear confident, it does not have a deep understanding of the subject matter (Rudolph et al., 2023). Integrating generative artificial intelligence into constructivist learning approaches, which seek to apply knowledge, are likely to be more effective at developing reasoning and critical thinking (Driscoll, 2013). To achieve this, supporting students in reflection is likely to be key, as this allows students to make sense of their own experiences and interactions. Reflection promotes the development of higher-order thinking skills, professional practice, and structured learning through experience (Coulson & Harvey, 2013). Inadequate reflection can undermine the learning process, which poses a challenge for educators, as reflection has been

found to be a challenging for some students (Bell, 2020). To support effective reflection, it has been suggested that educators should seek to foster a trusting, open and low-risk environment (Mueller & Anderson, 2014).

To be able to use generative artificial intelligence effectively, students need to critically understand how to utilise it. Part of this is likely to come from effective teaching of its application. Farrokhnia et al. (2023) highlight that students need to develop an understanding of the right questions and prompts to ask, to get the answers and feedback which they are seeking. Asking the wrong thing can generate feedback which is not supportive to learning and development (Latifi et al., 2021). Experience of applying generative artificial intelligence in practice is also important. This allows individuals to utilise the technology in their own context, although the requisite critical thinking and practical skills are required to effectively achieve this.

Fostering the development and assessment of practical and technical entrepreneurial skills

The continued development of generative artificial intelligence and other technologies changes the dynamic of what skills are required to support entrepreneurship in the future. It has long been posited that effective entrepreneurship education should support the development of entrepreneurial competencies and skills, through practical 'hands-on' learning (Bell, 2015; Lackéus and Williams-Middleton 2015), with more practical teaching contributing more to supporting students to follow the entrepreneurial process (Lyu et al., 2023). As the technology utilised in entrepreneurship continues to evolve, educators need to be reflexive, and open and willing, to adapt and innovate their own curricular and teaching, to ensure that students are taught the appropriate skills for future entrepreneurial endeavours. Whilst challenges and barriers exist for educators to transition to more practically focused entrepreneurship education, and many educators may be happier to stick with familiar educational principles and follow the path of least resistance (Bell & Liu, 2019), the development of practical skills is likely to only become more important. With the continued growth, development, and utilisation of technology within the entrepreneurship process, those without the familiarity and skills to take advantage of this technology will be at a greater disadvantage. This increases the importance of ensuring graduates leave with the technological skills to be competitive in both entrepreneurship and the employment market. To support fostering the development of practical entrepreneurship skills, these should be assessed through authentic activities and tasks, which demonstrate students' skills through application and the ability to manage contextual factors and ambiguity (Gijbels et al., 2005; Morselli & Gorenc, 2022). Such changes to assessment are also likely to be more secure from potential academic misconduct, using generative artificial intelligence, as reflection on learning from experiences is unique to the individual and cannot be easily copied by artificial intelligence. Adopting such authentic assessments, that assess students' skills, knowledge, and learning from realistic experiences have been recommended as a way to reduce potential plagiarism concerns in the era of artificial intelligence (Rudolph et al., 2023).

Conclusion

Generative artificial intelligence will have wide ranging implications for society, impacting numerous fields including education, business, and entrepreneurship (Dwivedi et al., 2023). In turn, it will have implications for entrepreneurship education and influence pedagogy, in terms of what happens within the entrepreneurship classroom. It will impact educators, students, what is covered, and how it is delivered in the classroom. Given the seeming inevitability of generative artificial intelligence working into everyday life, it should be managed and carefully leveraged (Short & Short, 2023). This requires entrepreneurship educators to develop curricula to teach students about generative artificial intelligence and foster the skills and competencies to allow students to effectively utilise the technology, but educators also need to understand how artificial intelligence affects pedagogic practice and assessment. Generative artificial intelligence can be integrated into education 'about', 'for' and ' through' entrepreneurship, but it might have the biggest implications for teaching 'about' entrepreneurship, as it has the potential to increase students access to information, which is often the main role of the teacher, and presents possible challenges to accessing students understanding of a subject through the writing of assignments and essays (Farrokhnia et al., 2023).

Given the growth and potential importance of artificial intelligence in the future in society and the entrepreneurial process, students will need to be able to use such technology to take advantage of future opportunities. Students lacking the ability to use such technology will be at a disadvantage in both entrepreneurial endeavours and employment prospects. Therefore, the development and assessment of practical and technical entrepreneurial skills is important.

However, Wahl and Münch (2022) suggest that currently many entrepreneurship education programmes are focused on generic entrepreneurship concepts and fail to teach and develop skills relating to essential technologies driving industry 4.0. Greater emphasis on technology and artificial intelligence can be achieved by ensuring that entrepreneurship is not viewed as an isolated discipline but with digital and technology expertise integrated into the entrepreneurship curricular. This can be supported through ensuring more explicit guidance and policy detailing the role and importance of embedding technology within entrepreneurship education and supporting educators who are not familiar with the latest technology.

The development of critical thinking skills will remain important, as these skills are important for both the entrepreneurial process and effectively using and harnessing the potential of artificial intelligence. However, debate exists around how generative artificial intelligence will impact the development of critical thinking skills (e.g., Cotton et al., 2023; Dwivedi et al., 2023). The teaching of generative artificial intelligence needs to ensure that students can critically appraise its outputs and understand how it can be effectively utilised in specific individual contexts. This can be supported through constructivist learning and reflection, where students make sense of experiences based on their own context (Driscoll, 2013). However, educators need to balance the promotion and

advocation of the benefits and value of generative artificial intelligence, against its limitations, as students need to understand that artificial intelligence does not possess deep understanding and can produce spurious information and outputs (Bender & Koller, 2020; Liang et al., 2022).

Given that generative artificial intelligence is a relatively new and evolving topic, there are numerous research directions and opportunities in relation to entrepreneurship education, which would help to move the field forward. Little is still known as to how students view artificial intelligence, their comfort level with the technology, and how they respond to it in the classroom. Further research as to potential barriers and challenges to integrating technology and artificial intelligence in the entrepreneurship classroom, from different perspectives, such as educators, students, and administration, and how these can be mitigated and overcome, would support teaching at a practical level. Additionally, we require further research into the specific skills students need to be able to take advantage of artificial intelligence in the entrepreneurship process, and how these skills can be effectively assessed within entrepreneurship education. Finally, at a more macro level, research could explore whether, and how, artificial intelligence and technology will shape entrepreneurship education differently in the future, as these advances become more important within industry 4.0.

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical approval This paper does not include primary data collected from human participants.

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