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Advancing quality education through educational tools in business education: A bibliometric analysis in support of SDG 4

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Abstract: This study explores the evolving role of educational tools in business education and examines how these tools contribute to the advancement of Sustainable Development Goal 4 (SDG 4), which emphasizes inclusive and equitable quality education and lifelong learning opportunities for all. Based on the emerging trend of the confluence of technology, pedagogy, and sustainability in the literature, the present study was designed with the intention of employing the research design approach of utilizing the bibliometric method to ascertain the trends and intellectual structure of the literature on technology-enhanced business education. The literature consisted of 256 peer-reviewed articles published in the Scopus database from 2015 to 2025. The literature was obtained from the database using advanced keywords. The present study employed advanced bibliometric techniques such as citation analysis, co-citation analysis, and co-word mapping to ascertain the trends in the literature. The findings of the present study reveal an increase in the literature on the subject in the past decade. This reflects the rising interest in the application of artificial intelligence-based tools, experiential and technology-based learning environments, and sustainability-based pedagogies in business education. The literature reveals the following theoretical underpinnings in the subject: the Theory of Planned Behavior, the Experiential Learning Theory, and the Resource-Based View. These theories collectively explain the application of technology in business education. The present analysis is a reflection of the shift from traditional methodologies of instruction to data-driven, interactive, and learner-centric tools in business education. These tools are in consonance with the objectives of the Sustainable Development Goal 4. From the perspective of the application of the findings of the present study in the business world, the analysis is a reflection of the need for higher educational institutions to invest in the application of digital technologies in business education. This application of digital technologies is essentially required in the digitalized business world to maximize the effectiveness of the educational process. This study, through the provision of a comprehensive synthesis of research trends and intellectual foundations, presents original value for educators, researchers, and policymakers who require insights into strategic decision-making, research trends, and formulation of policies in technology-enhanced business education in consonance with global sustainability goals.

Keywords: business education; educational tools; technology-enhanced learning; entrepreneurship education; gamification; sustainable development goal 4; education policy

1. Introduction

The dynamic landscape of business education has evolved significantly through the integration of educational tools that enhance learning outcomes and prepare

students for the complexities of the modern business environment. As globalization, technological advancements, and the digital economy reshape industry expectations, business schools and educators are increasingly leveraging digital tools, business intelligence (BI) solutions, and artificial intelligence (AI) applications to foster practical learning experiences [1]. These tools not only bridge the gap between theoretical knowledge and practical application, but they also help inculcate essential skills such as analytical thinking, problem-solving, and digital literacy among students [2]. The use of these educational tools has been recognized as a crucial factor in shaping competent professionals ready to tackle contemporary business challenges [3].

Business intelligence tools play a significant role in transforming knowledge management and dissemination within educational institutions. By leveraging data analytics and predictive modeling, BI tools enable students to gain insights into market trends, financial performance, and informed strategic decision-making [4]. These tools foster responsible business practices by encouraging data-driven decision making and promoting transparency within organizations. However, the effectiveness of BI tools in education is influenced by institutional culture and the availability of adequate training [5]. Without proper integration and continuous faculty development, the full potential of these tools may remain underutilized. Thus, educational institutions must prioritize training initiatives to equip instructors and students with the necessary competencies to maximize the benefits of BI technologies.

Artificial intelligence is another transformative force in business education. AI-powered tools have revolutionized the learning experience by facilitating personalized learning pathways, automating administrative tasks, and enhancing student engagement through intelligent tutoring systems [6,7]. AI-driven analytics helps educators assess student performance more accurately, allowing tailored interventions that address individual learning needs. For instance, in India, business schools have successfully integrated AI-driven solutions into their curricula, showcasing the practical application of AI in enhancing student competencies [8]. These AI tools not only prepare students for the evolving job market but also cultivate an innovation-driven mindset that is critical for future business leaders. Despite these advantages, the adoption of AI in education remains challenging. Concerns regarding data privacy, algorithmic bias, and the ethical implications of AI usage must be addressed to ensure the responsible and equitable implementation of AI.

Digital tools have also emerged as vital components of entrepreneurship education, offering students immersive learning experiences through simulations, gamification, and virtual business environments [9]. Digital platforms enable students to apply entrepreneurial concepts in simulated real-world scenarios, thereby enhancing their problem-solving skills and business acumen. These tools provide opportunities for experiential learning, allowing students to experiment with different business strategies, analyze market responses, and refine their decision-making skills in a risk-free environment. However, the successful integration of digital tools in business education is contingent on students' digital literacy levels [10,11]. A lack of technical proficiency and resistance to the adoption of digital tools can hinder their effective use. Therefore, educational institutions should emphasize digital literacy training to ensure that students can effectively navigate and leverage digital tools for entrepreneurial success.

The importance of digital literacy in business education extends beyond entrepreneurship and is fundamental for preparing students for the 21st-century workforce. As businesses increasingly rely on data-driven strategies and digital platforms, students must acquire proficiency in tools such as data analysis software, project management applications, and collaborative platforms [12]. These tools help students develop critical skills like teamwork, flexibility, and thinking strategically, all of which are highly prized in today's business world. To address the growing demand for digital skills, business schools must integrate relevant technologies into their curricula and provide students with hands-on learning experiences that align with industrial standards [13]. In addition, partnerships with technology providers and industry leaders can facilitate access to cutting-edge tools and real-world case studies, thereby enriching the learning experience.

Despite the numerous benefits of educational tools in business education, challenges remain for their effective implementation. Infrastructure limitations, faculty resistance to change, and inadequate training opportunities can impede seamless adoption of technology in learning environments [14]. In order to overcome these challenges, educational institutions must take a dual approach: leveraging technological advancements while simultaneously addressing the challenges associated with digital transformation. Investing in faculty development programs, upgrading infrastructure, and fostering a culture of innovation within academic institutions can ensure that technology-enhanced business education is relevant, inclusive, and impactful.

The integration of educational tools in the field of business education is likely to have the potential to enhance the outcome of the learning process and enable the acquisition of skills that are vital in the modern world of business. The use of business intelligence tools, as well as the application of artificial intelligence, provides an innovative approach to bridging the gap between theoretical and practical knowledge, creating an exciting and motivating learning experience [15]. However, the implementation of the educational tools requires the elimination of the challenges that are likely to affect the process. The field of business education is likely to evolve and meet the challenges presented by the digital and competitive world through the application of a strategic approach.

The main aim of this study was to examine the scientific landscape of the use of educational tools in the field of business education with the aid of publication trends and patterns using the technique of bibliometric. This study aims to comprehend the use of various technologies like artificial intelligence (AI) and business intelligence (BI) and digital platforms and simulators in the field of business education and how they are changing the face of traditional teaching and learning methodologies in the field of business education. Moreover, this study aims to comprehend the influence of educational tools on the learning process of students and how they contribute to the achievement of the sustainable development goal of quality education (SDG 4) and the challenges and opportunities of the use of these tools in the classroom. This study provides a greater understanding of the use of technology in the field of business education and how it can be improved.

2. Methods

This study employed a bibliometric analysis to systematically explore the scholarly landscape surrounding the use of educational tools in business education, with a particular emphasis on supporting (SDG 4) – Quality Education. Bibliometric analysis is a quantitative research method used to identify patterns in the scientific literature, including publication trends, authorship, citation networks, and thematic structures [16].

The data were collected from the Scopus database, which was selected for its comprehensive coverage of peer-reviewed literature across disciplines. A total of 256 documents published between 2015 and 2025 were retrieved. The search strategy was guided by a Boolean logic approach that combined the two primary groups of keywords. The first group focused on educational technologies and tools using terms such as “Education Tool*,” “Teach* Tool*,” “Learning Resource*,” “Digital Learning Tool*,” “E-learning Technology*,”* and “Pedagogical Tool.”* The second group targeted the Business Education context with keywords such as “Business Education,” “Management Education,” “Entrepreneurship,” “Startup Education,” and “Small Business Training.” The use of wildcards (*) allowed for broader retrieval of related terms and variations, ensuring a wide net of relevant literature. The AND operator was used to refine the search such that the results reflected the intersection of both keyword groups.

After the retrieval of the data, various analyses can be performed with the aid of the bibliometric mapping tools such as VOSviewer. This includes citation analysis, which identifies the most cited works in the database; co-citation analysis, which measures the number of times the works are cited together and thus establishes the intellectual linkages between them; and co-word analysis, which identifies the keywords and establishes the research focus and theoretical foundations of the works.

This approach was intended to give a thorough overview of the academic discourse on educational tools in the field of business education and the knowledge networks surrounding the field of study.

3. Results and discussion

In this section, the key findings from the bibliometric study of 256 documents on the concept of educational tools in the domain of business education are outlined. The findings provide an overview of the development in the number of scholarly papers published over the years, the most cited papers that have made a notable contribution to the domain, and the intellectual structure of the domain through co-citation and co-word analyses, which are instrumental in understanding the use of technology in the development of entrepreneurship, innovation, and learning in the domain of business education, as outlined in the objectives of achieving the fourth SDG in quality education.

The Scopus trend analysis of 256 documents on technology tools in business education from 2015 to 2025, as shown in **Figure 1**, reveals fluctuating yet increasing research interest. In 2015, the number of publications started at approximately 10 documents, rising steadily to 30 by 2017. This early growth indicates an increasing interest in digital learning tools and pedagogical innovation. However, the decline in

2018 suggests a temporary shift in research focus or funding.

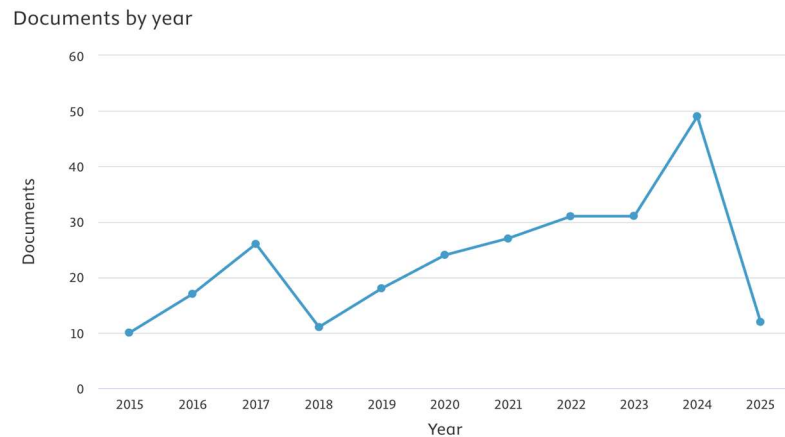


Figure 1. Number of publications and citations (Source: Web of Scopus).

From 2019 onward, a gradual increase was reflected, indicating renewed attention to e-learning, AI-driven instruction, and digital pedagogy in business education. The trend remains stable between 2022 and 2023, indicating sustained scholarly engagement, likely due to the expansion of blended and online learning models.

A notable spike in 2024, with over 50 publications, suggests a surge in research, possibly driven by post-pandemic digital transformation and advancements in AI, virtual reality, serious games, and corporate investments in entrepreneurship education. However, 2025 shows a sharp decline, dropping close to 2015 levels. This could be due to incomplete indexing, a shift in research priorities, or reduced funding of digital learning studies.

Therefore, the body of literature on technology tools in business education has expanded considerably. The expansion was significant in 2024, driven by the interest in AI and immersive technologies. The drop in 2025 may be subject to further analysis to ascertain if it was a data dip or a shift in academic focus. Further analysis of the most influential authors, institutions, and topics may be obtained from the bibliometric analysis.

3.1. Citation analysis

By using document citation analysis, the most cited papers among the documents are identified and presented in **Table 1**. The most cited papers are Chen et al. [17], with 218 citations, Aragon-Correa et al. [18], with 75 citations, and Fernandez et al. [19], with 48 citations. The cited papers indicate the importance and relevance of the papers to the academic community.

3.1.1. Trends and emerging themes in business education tools

The role of artificial intelligence (AI) and big data analytics in business education is a rapidly growing research area. Chen et al. [16], the most cited study, highlighted the impact of AI-driven student assistants (chatbots) in enhancing student success, demonstrating the potential of AI in creating personalized and adaptive learning experiences. Similarly, Thanasi-Boçe [21] and Shah et al. [22] discussed AI

applications in human resource management and organizational decision-making, emphasizing how big data analytics is shaping business education and workforce training. These studies suggest that AI-powered simulations, predictive analytics, and automation are becoming essential in modern business education, allowing students to gain real-world insights and experience in data-driven decision making.

Table 1. Top 10 highest-cited documents.

No	Authors	Title	Citations
1	Chen et al. [17]	Artificial Intelligence (AI) Student Assistants in the Classroom: Designing Chatbots to Support Student Success	218
2	Aragon-Correa et al. [18]	Sustainability management teaching resources and the challenge of balancing planet, people, and profits	75
3	Fernandez et al. [19]	Process intensification education contributes to sustainable development goals. Part 1	48
4	Naidoo [20]	Enhancing students' entrepreneurial capacity through marketing simulation games	44
5	Thanasi-Boçe [21]	Artificial intelligence in human resources management: Challenges and a path forward.	37
6	Shah et al. [22]	Big data in an HR context: Exploring organizational change readiness, employee attitudes and behaviors.	36
7	Wolff et al. [23]	The PRIDE (Partnership to Improve Diabetes Education) Toolkit: Development and Evaluation of Novel Literacy and Culturally Sensitive Diabetes Education Materials	33
8	Goeman et al. [24]	Optimising Health Literacy and Access of Service Provision to Community Dwelling Older People with Diabetes Receiving Home Nursing Support	32
9	Ramli et al. [25]	Mediating role of E- learning resources in developing entrepreneurial inclinations amongst undergraduate students at Universiti Utara Malaysia	32
10	Rivers et al. [26]	Embedding social innovation and social impact across the disciplines Identifying "Changemaker" attributes	31

Beyond technology, business education also integrates sustainability and social impact as its core principles. Aragon-Correa et al. [18] and Fernandez et al. [19] highlight how sustainability management education balances profit-making strategies with environmental and social responsibilities, aligning business curricula with Sustainable Development Goals (SDGs). Additionally, Rivers et al. [26] discussed embedding social innovation and changemaker attributes into education, reinforcing the idea that business students should be prepared for ethical leadership roles that contribute positively to society. This trend signals a shift towards producing socially conscious graduates who can navigate the complexities of responsible business management.

Digital learning and gamification have emerged as powerful tools in business education. Holtzhausen [20] and Ramli et al. [25] demonstrated how simulation games and e-learning resources enhance entrepreneurial skills and offer experiential learning opportunities that bridge the gap between theory and practice. By immersing students in interactive, real-world business scenarios, gamification fosters critical thinking, problem solving, and decision-making skills, making education more engaging and effective. Furthermore, while Wolff et al. [23] and Goeman et al. [24] focused on health literacy tools, their findings suggest that similar educational strategies could be applied to business education, particularly in corporate training and professional development.

3.1.2. Trends and emerging themes in business education tools

The citation trends in these research articles show that newer innovations in AI, sustainability, and gamification have become the focal point in business education research. The study by Chen et al. [17], which is recent in nature, has already received 218 citations. This shows the growing academic interest in AI-based tools in education. The citation trends in the study on gamification in business education range from 30-75. Similarly, the study on entrepreneurship in business education is gaining traction with a citation count of around 40. It is interesting to note that the older research articles from 2015-2016 have fewer citations. It is thus obvious that AI-driven, data-driven, and technology-driven learning methods in business education are the trends.

The citation trends in the research articles have significant implications for business education. The trends in AI, chatbots, big data analytics, gamification, and sustainability in business education show that business education is shifting towards more personalized, real-time, and interactive learning methods. The inclusion of sustainability in business education ensures that the students not only learn profit-driven business strategies but also become adept at making socially responsible decisions. The trends in gamification in business education show that simulation-based learning will be the key in business education in the days to come. The AI-powered chatbots will enhance the learning process in business education in the days to come. The gamification trends in business education will significantly impact the entrepreneurial skills of business students. Sustainability will continue to be the key in business education in the days to come. Business education is evolving towards a technology-enhanced, socially responsible, and simulation-based learning model that will prepare the next-generation business leader who is not only innovative in his business decisions but also socially responsible in his entrepreneurial endeavors.

3.2. Co-citation analysis

Table 2 presents the top ten most co-cited documents in entrepreneurship and business education, which emphasize foundational theories, entrepreneurial motivation, and the role of education in shaping entrepreneurial skills. Barringer and Ireland [27] and Mycoskie [28] had the highest total link strength (33), indicating their strong influence on research in entrepreneurial development and business innovation. Barringer and Ireland's work explores key aspects of entrepreneurship, while Mycoskie's book, *Start Something That Matters*, highlights social entrepreneurship and purpose-driven business ventures, reflecting a growing interest in

entrepreneurship with a social impact.

Table 2. Top 10 documents with the highest co-citation and total link strength.

No.	Documents	Citation	Total link strength
1	Barringer BR and Ireland RD. (2012) <i>Entrepreneurship: Successfully Launching New Ventures</i> . 14th Edition, Pearson Education Inc, Upper Saddle River. [27]	3	33
2	Mycoskie B (2012). <i>Start something that matters</i> . Random House. [28]	11	33
3	Oosterbeek H, et al., (2010). The impact of entrepreneurship education on entrepreneurship skills and motivation. <i>European economic review</i> , 54(3): 442 – 454. [29]	5	29
4	Ajzen I. (1991). The theory of planned behavior. <i>Organizational behavior and human decision processes</i> . 50(2): 179 – 211. [31]	8	28
5	Deakins D and Freel M. (2012). <i>Entrepreneurship and small firms</i> 6e. McGraw hill. [32]	4	28
6	Burns P. (2022). <i>Entrepreneurship and small business</i> . Bloomsbury Publishing. [33]	3	24
7	Barney J. (1991). Firm resources and sustained competitive advantage. <i>Journal of management</i> . 17(1), 99 – 120. [34]	4	18
8	Piperopoulos P and Dimov D. (2015). Burst bubbles or build steam? Entrepreneurship education, entrepreneurial self-efficacy, and entrepreneurial intentions. <i>Journal of small business management</i> . 53(4): 970 – 985. [30]	3	17
9	Christensen CM, et al., (2009). <i>The Innovator's Prescription: A Disruptive Solution for Health Care</i> . New York: McGraw-Hill. [35]	3	15
10	Iandoli L and Zollo G. (2022). <i>Elegant Design: A Designer's Guide to Harnessing Aesthetics</i> . Bloomsbury Publishing. [36]	5	15

Another influential study is Oosterbeek et al. [29], which has a total link strength of 29, examining the impact of entrepreneurship education on students' motivation and skills. This is similar to Piperopoulos and Dimov [30] (17 link strength), who examine the efficacy of entrepreneurship education in developing entrepreneurial intent and self-efficacy. This research points to the importance of education in developing future entrepreneurs.

Ajzen's [31] Theory of Planned Behavior (28 link strength) remains a foundational framework for understanding entrepreneurial intentions, providing insights into how attitudes, subjective norms, and perceived behavioral control influence entrepreneurial behavior. Similarly, Deakins and Freel [32] (28 link strength) and Burns [33] (24 link strength) focus on entrepreneurial growth and small business management, emphasizing sustainable business development.

In terms of strategic business foundations, Barney [34] (18 link strengths) introduced the resource-based view (RBV), which explains how firms gain competitive advantage through unique resources. Finally, Christensen et al. [35] (15 link strengths) discuss disruptive innovation in entrepreneurship, and Iandoli and Zollo [36] (15 link strengths) explore the role of aesthetics and design thinking in

entrepreneurship, showcasing the multidimensional aspects of modern entrepreneurial ventures.

Based on network visualization, co-citation analysis produced four distinct clusters. **Figure 2** shows the network structure of co-citation analysis. Each cluster was labeled and characterized based on representative publications, as interpreted by the authors, according to their inductive understanding of the four clusters.

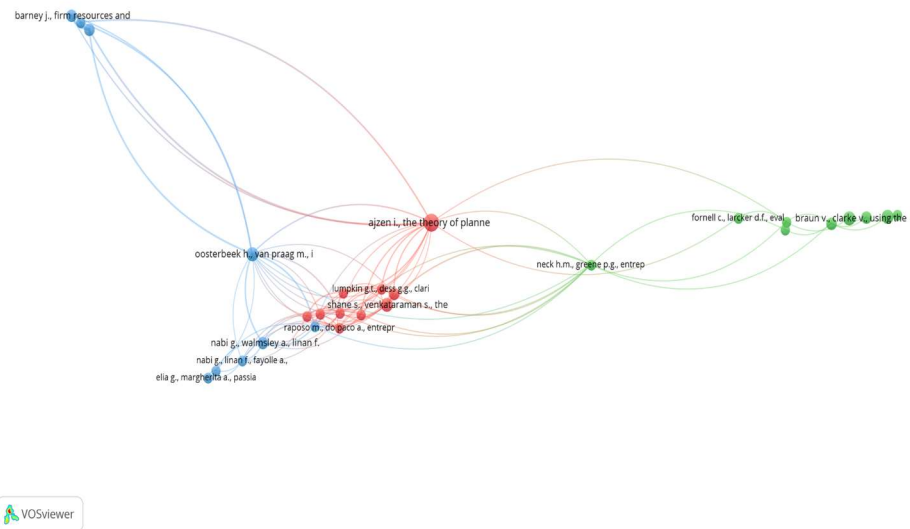


Figure 2. Co-citation analysis of the role of educational tools in business education.

- **Cluster 1 (Red):** This cluster deals with the theory and research on entrepreneurial intention, orientation, and education and its influence on entrepreneurship development. The main idea behind this cluster is based on Ajzen's Theory of Planned Behavior, which is a foundational theory for understanding entrepreneurial intention through attitudes, subjective norms, and perceived behavioral control, as presented in reference [31]. Krueger et al.'s research on competing models of entrepreneurial intent extends the psychological and cognitive aspects of entrepreneurship, as presented in reference [37]. Shane and Venkataraman's research on opportunity recognition and resource mobilization helps to legitimize entrepreneurship research, as presented in reference [38]. Lumpkin and Dess introduced entrepreneurial orientation and its link to entrepreneurial performance, as presented in reference [39]. Sarasvathy [40] extends this approach with the introduction of the effectuation theory, which distinguishes between predictive and flexible opportunity-driven approaches to decision-making in entrepreneurial contexts. Entrepreneurship education was a significant finding of this group of papers. Sun et al [41] demonstrated that entrepreneurship education enhances entrepreneurial mindset and intention, while Egbetokun and colleagues [42] demonstrated that entrepreneurship education produces lasting attitudinal change among students. Entrepreneurial self-efficacy and its influence on student aspirations are emphasized by Piperopoulos and Dimov [30], which corresponds with the findings of Fayolle and Gailly [43] on individual entrepreneurial intent.

- Cluster 2 (green): Cluster 2 discusses the methodologies adopted in entrepreneurship studies and the importance of experiential learning methodologies, simulations, and gamification in entrepreneurship education. The foundation for the methodologies was set through important studies on qualitative and quantitative methodologies. Braun and Clarke's [44] thematic analysis provides the foundation for qualitative methodologies, while Cohen's [45] statistical power analysis and Fornell and Larcker's [46] structural equation modeling are important methodologies for statistical analysis in entrepreneurship studies. The importance of statistics education in business schools is discussed by Hijazi [47], highlighting the need to have strong methodologies in place. Apart from methodologies, experiential learning as an important factor in entrepreneurship education is discussed in this cluster. Kolb's [48] experiential learning theory provides the foundation as an important concept that advocates the need to learn through experiences. Neck and Greene [49] built upon this by exploring how entrepreneurship education evolves through innovative teaching methods. The use of simulations and serious games has emerged as a significant trend, with Fox et al. [50] and Pasin and Giroux [51] demonstrating their effectiveness in enhancing entrepreneurial decision-making skills. Additionally, Gatti et al. [52] examine sustainability-focused business simulations, reinforcing the role of gamification in fostering responsible entrepreneurship.
- Cluster 3 (blue): The third cluster is concerned with the link between entrepreneurship education, firm growth, and the changing digital entrepreneurship ecosystem. This cluster examines the influence of entrepreneurship education on entrepreneurial intention and firm growth while incorporating contemporary trends like digitalization. One of the basic theories in this cluster is Barney's [34] resource-based view (RBV), which focuses on the way firms can attain a sustainable competitive advantage by utilizing unique resources. Burns [33] and Deakins and Freel [32] expanded on this by examining small business growth, firm dynamics, and entrepreneurial success factors. A key theme in this cluster is the role of entrepreneurship education in fostering an entrepreneurial mind-set and skills. Kuratko [53] outlines the historical evolution and challenges in entrepreneurship education, while Nabi et al. [54] systematically review its impact on higher education, emphasizing learning and inspiration as drivers of entrepreneurial intentions. Oosterbeek et al. [29] and Souitaris et al. [55] provide empirical evidence of how entrepreneurship programs influence skills, motivation, and career choices. A modern addition to this list is the digitalization of entrepreneurship. Elia et al. [56] discuss the development of digital entrepreneurship ecosystems, where digital technologies and collective intelligence change traditional processes of entrepreneurship.

Table 3 summarizes the co-citation analysis by presenting its clusters, cluster labels, number of articles, and representative publications.

Table 3. Co-citation clusters on the role of educational tools in business education.

Cluster	Cluster label	Number of articles	Representative publications
1 (red)	Integrating Resource Management, Experiential Learning, and Digital Transformation	10	Ajzen I. [31], Krueger et al. [37], Shane et al. [38], Lumpkin et al. [39], Sarasvathy [38]
2 (Green)	Experiential Learning, Simulations, and Statistical Rigor	9	Braun and Clarke [44], Cohen [45], Hijazi [47], Fornell and Larcker [46], Fox et al. [50], Gatti et al. [52], Kolb [48], Neck and Greene [49], Pasin and Giroux [51]
3 (Blue)	Bridging Resource Management, Experiential Learning, and Digital Transformation	9	Barney [34], Burns [33], Deakins and Freel [32], Elia et al. [56], Kuratko [53], Nabi et al. [54], Oosterbeek et al. [29], Souitaris et al. [55]

3.2. Co-citation analysis

A co-word analysis was applied to the same database. From the 1620 keywords, 49 met the minimum of six occurrences, resulting in two clusters. Based on **Table 4**, the keywords with the highest co-occurrence were “students” (177), “humans” (159), and “humans” (125). **Table 5** summarizes the top 15 co-occurring keywords with their number of occurrences and total link strength.

Table 4. Top 15 keywords in the co-occurrence of keywords analysis.

Ranking	Keyword	Occurrences	Total link strength
1	Students	45	177
2	Human	25	159
3	Humans	20	125
4	Education	31	113
5	Self care	15	107
6	Teaching	22	107
7	Article	12	93
8	E-Learning	21	86
9	Female	11	84
10	Male	10	82
11	Adult	10	75
12	Curricula	18	72
13	Patient Education	9	72
14	Procedures	9	68
15	Entrepreneurship	28	67

Figure 3 presents a network map of the co-word analysis. The map produced four clusters, which were classified and labeled based on the author’s inductive interpretation of the occurring words. All clusters were closely related and partially integrated.

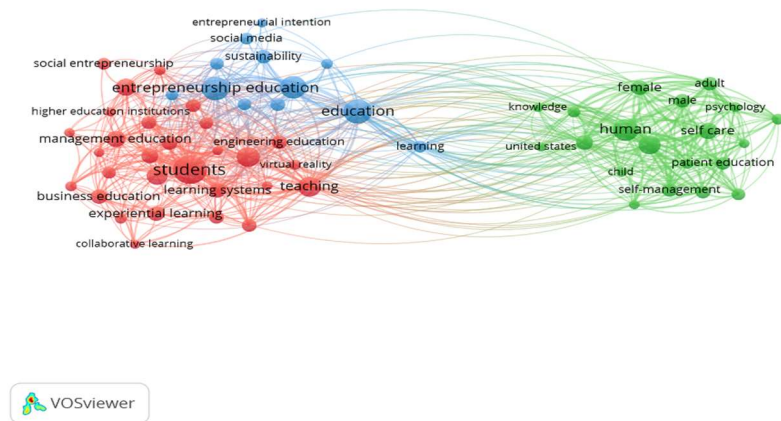


Figure 3. Co-word analysis on the role of educational tools in business education.

- **Cluster 1 (red):** This cluster represents research focusing on teaching methodologies, learning systems, and business education. The most frequently cited keywords included students, education, teaching, learning systems, higher education, and business education. The presence of terms such as education, computing, innovation, and sustainability suggests a strong emphasis on technology-enhanced education and entrepreneurial thinking [31,29]. Additionally, keywords such as social entrepreneurship, pedagogy, and student engagement indicate that research is exploring how business education integrates entrepreneurial skills and leadership development [38]. The inclusion of management education and computer-aided instruction points to growing interest in digital learning environments and active learning methodologies [49]. This cluster highlights how experiential learning, business simulations, and e-learning platforms are utilized to enhance student engagement and academic performance.
- **Cluster 2 (green):** This cluster focuses on health literacy, patient education, and self-care practices. The most frequently cited keywords included humans, self-care, patient education, procedures, adult, female, male, and diabetes mellitus. Research in this cluster examines how controlled studies assess the effectiveness of educational interventions in healthcare settings [44,45]. The connections between self-care, patient education, and procedures suggest that a major research focus is empowering individuals with medical knowledge and self-management skills through digital education tools and personalized learning strategies [52]. Controlled studies suggest that quantitative methodologies are commonly employed to assess the impact of patient education [46].
- **Cluster 3 (blue):** This cluster focuses on technology-enhanced pedagogy in entrepreneurship and innovation within business education. The selected studies highlighted how digital tools, pedagogical frameworks, and social media support entrepreneurial learning, skill development, and innovation-driven education. Several studies have emphasized the role of digital learning environments in fostering entrepreneurial intention and competency development [57]. E-learning platforms and pedagogical tools are

increasingly being used to cultivate entrepreneurial mindsets by providing interactive, real-world business scenarios [58]. Additionally, social media platforms serve as powerful educational tools that facilitate networking, knowledge sharing, and experiential learning [59]. Another key theme is the integration of arts-based and innovative teaching methods to promote creative thinking in entrepreneurship education [58]. The use of SWOT analysis and business simulations has been identified as an effective approach for reinforcing decision-making and problem-solving skills [60]. Furthermore, discussions on sustainability in entrepreneurship education stress the need for business curricula to embed the environmental and social responsibility aspects [61].

Table 5 summarizes the co-word analysis represented by the cluster label, number of keywords, and representative keywords.

Table 5. Co-word analysis on technology tools in business education.

Cluster No and color	Cluster label	Number of keywords	Representative Keywords
1 (red)	Technology-Enhanced Learning Tools in Business Education	15	educational tools, computer aided instruction, e-learning, education computing, learning systems, virtual reality, serious games, social media, digital tools, online learning, learning management systems (LMS), simulation-based learning, instructional technology, educational technology, interactive learning platforms
2 (green)	Technology-Enhanced Learning for Professional and Adult Education	13	adult, article, controlled study, mellitus, female, human, humans, male, non insulin dependent diabetes mellitus, patient education, patient education as topic, procedures, psychology, self care, self-management
3 (blue)	Technology-Enhanced Pedagogy for Entrepreneurship and Innovation in Business Education	12	education, entrepreneur, entrepreneurial education, entrepreneurial intention, entrepreneurship, entrepreneurship education, innovation, learning, pedagogical tools, pedagogy, social media, sustainability

4. Discussion

The findings of the present study will offer significant insights into the theoretical as well as practical implications in the context of advancing business education. As the educational sector is embracing the integration of digital tools and innovations in the realm of education, it is vital to understand the trends, theories, and applications of such tools in the process. The present study is an attempt to contribute towards the debate in the domain of the application of technology-enhanced learning in the context of student engagement, entrepreneurial education, and the achievement of the fourth goal of the UN's Sustainable Development Goals. The next section will shed more light upon the theoretical as well as practical implications of the present study.

4.1. Theoretical implications

The bibliometric analysis presented in this paper is relevant with respect to the theoretical implications it has for business education, educational technology, and

entrepreneurship education, especially with respect to SDG4. It demonstrates the interface of basic and emerging theories relevant to the understanding of digital technologies and innovations in business education.

One key implication lies in the integration of behavioral and entrepreneurial intention theories with digital learning. Studies frequently co-cited, such as Ajzen's [31] Theory of Planned Behavior and Krueger et al. [37], suggest that technology-enhanced education influences learners' attitudes, perceived control, and intentions toward entrepreneurial activities. These theoretical foundations underscore the role of educational tools not only as instruments of instruction but also as mediators of behavioral and cognitive change, especially in shaping the entrepreneurial mindset and self-efficacy.

Furthermore, the prominence of experiential learning theory [48] in the analysis validates its relevance to digital pedagogy. Simulations, serious games, and AI-driven platforms reflect Kolb's experiential cycle in which learners engage, reflect, conceptualize, and apply knowledge. These tools redefine how experiential learning can be scaled and personalized in business education.

Another major implication comes from strategic management theory, particularly Barney's [34] Resource-Based View (RBV). This suggests that educational tools, when embedded effectively, become strategic assets that confer a competitive advantage, transforming educational institutions and learners into innovation-driven entities.

4.2. Co-citation analysis

This bibliometric analysis has several important practical implications for educators, policymakers, and instructional designers in the field of business education, especially with regard to the promotion of SDG 4.

First, it underscores the growing importance of AI-powered educational tools, such as chatbots and intelligent tutoring systems, in enhancing student engagement and learning outcomes. The work highly cited by Chen et al. [17] highlights the role of chatbots in supporting student success through personalized learning pathways. This suggests that institutions should invest in adaptive learning technologies that tailor content to individual learners' needs, improving both academic performance and student satisfaction.

Second, the findings support the integration of experiential and simulation-based learning, including serious games and business simulations (e.g., Holtzhausen [20]; Ramli et al., [25]). These tools allow students to experience a hands-on, immersive approach that closes the gap between theory and practice. Educators are encouraged to use gamified learning environments that promote entrepreneurial thinking, problem-solving, and strategic decision-making skills that are required for success in the business world.

Thirdly, this study supports the importance of incorporating sustainability and ethical leadership into business education [18, 19]. The inclusion of sustainability in digital media can play a vital role in developing business skills in students as well as instilling a sense of social responsibility in them.

Finally, the necessity to further train and educate the faculty in the field of digital

literacy was established as a theme in the research. The utilization of the educational tools depends on the training and capability of the instructors to effectively integrate the tools in the curriculum.

In summary, the study has established a clear roadmap to enhance business education using technology and has offered practical strategies to cultivate innovation, inclusion, and ethical leadership in conformity with international educational goals.

5. Conclusion

Through a bibliometric analysis of 256 documents retrieved from the Scopus database, this study explores the evolving role of educational tools in business education. The findings reveal growing academic interest in technology-enhanced learning, particularly in areas related to artificial intelligence (AI), business intelligence (BI), gamification, and sustainability-focused instruction. The study concludes that the application of these tools has greatly impacted business education, especially in terms of student engagement, personalized learning, and the development of student skills in real-world scenarios. For instance, the most referred works, like those done by Chen et al. [17], focus on the effects of AI-based tools like chatbots in assisting student success. In addition, the rise of simulations in the education of entrepreneurship is a move towards interactive and innovative teaching methods. Furthermore, the inclusion of sustainability in business education is a global movement towards promoting ethical leadership in business, in line with the promotion of SDG 4: Quality Education.

Despite its contributions, this study has some limitations. First, the study was based on the literature indexed in Scopus. Although it is a large database, there are possibilities of missing some literature from other scientific databases like Web of Science, ERIC, and Google Scholar. Such a limitation could have led to publication bias and a limited view of the research domain. Secondly, the search strategy employs a list of keywords. Although carefully selected, this approach may have excluded valuable studies that have used alternative or emerging terminology. The use of Boolean logic and wildcard symbols improved inclusivity, but the keyword-dependent nature of the search restricted the comprehensiveness of the results. Third, there is an overemphasis on quantitative bibliometric methods such as citation, co-citation, and keyword co-occurrence. While such methods can be useful in highlighting patterns and key studies, they do not evaluate the quality, rigor, and depth of individual studies. The qualitative aspects of the literature, such as its effectiveness as an educational tool or its effect on learners, might not be thoroughly explored. Additionally, it should be noted that the present study is based on literature published between 2015 and 2025. The literature published in recent years, particularly 2025, might not reflect enough citations, thereby indicating its relative lack of importance. However, it is also possible that such literature has simply had insufficient time to make its mark. The role of various contexts, such as business education programs, is also not taken into consideration.

Moreover, in light of the limitations, the following recommendations were proposed for the future research. First of all, the scope of the research would be widened to include other academic databases. This would give a more comprehensive

literature search. Secondly, the research would be done using the mixed-method research design. This would give deeper insights into the pedagogical implications. Third, there is a need for more context-sensitive research exploring how educational technologies are applied in different educational systems, geographic regions, and institutional settings. Finally, future work should investigate the long-term outcomes of using AI, simulations, and gamified learning in business education, particularly their impact on learner success, career readiness, and ethical decision making. These directions will enhance the understanding and support the strategic integration of educational tools for more inclusive, innovative, and effective business education.

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