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Article

Constructing a digital transformation framework in entrepreneurship education: Based on systematic literature review and theory triangulation

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Abstract: Entrepreneurship education plays a crucial role in improving college students' entrepreneurial skills. With the significant momentum gained by digital entrepreneurship, there is an urgent need for digital transformation in entrepreneurship education. However, entrepreneurship education digital transformation (EEDT) is developing in a rapid but fragmented manner, which requires more systematic guidance. This study aims to assess the current research themes and formulate a framework for entrepreneurship education digital transformation. The research employs a systematic literature review and a theory triangulation method. According to the review's outcome, which focused on 56 articles published between 2018 and 2023, the researcher constructed a conceptual framework for entrepreneurship education digital transformation. To test the construct validity of the framework, the researcher modified it twice through theory triangulation, following the guidelines of the entrepreneurship education ecosystem theory and the education digital transformation framework. This study offers recommendations for research and practice in digital transformation of entrepreneurship education, encompassing a holistic strategy, new educational approaches, novel curriculum designs, and the enhancement of digital literacy among entrepreneurship teachers.

Keywords: entrepreneurship education; digital transformation; digital technology; digital literacy; digital entrepreneurship skills; framework

1. Introduction

Entrepreneurship education plays an important role in improving the employability of university students (Bauman and Lucy, 2021), increasing their entrepreneurship willingness (Akhter et al., 2022; Ghafar, 2020), and stimulating economic growth (Gustav Hägg, 2021). Nowadays, the development of modern digital technologies such as big data, cloud computing, artificial intelligence and mobile communications have had a deep, unprecedented, and all-encompassing impact on production, lifestyle, and education (United Nations Educational, 2022). Moreover, the differences between digital and traditional entrepreneurship (Nambisan, 2017) have made the digital transformation of entrepreneurship education become inevitable (Kraus et al., 2021; Lesinskis et al., 2023). Entrepreneurship education must adapt to the digital transformation of society and industry to prepare students for the digital revolution.

The digital transformation is the process of using technologies to actively modify the operations of an organization's processes, capabilities, and patterns (Castro Benavides et al., 2022; Marks and Al-Ali, 2020; Wan and Fan, 2023). Digital transformation of Education is to adapt to the evolving knowledge, skills, and capacities of the global labor force (Alenezi, 2021). Compared with the great attention

to digital transformation of education and digital entrepreneurship, there is relatively little research related to digital transformation of entrepreneurship education (Kraus et al., 2019). The research on digital transformation in entrepreneurship education is scarce or just partly focuses on certain aspects (Fellnhofer, 2019; Kollmann et al., 2021; Sitaridis and Kitsios, 2023). The absence of holistic digital entrepreneurship education poses difficulties in keeping pace with the rapid improvements in digital technology (Sitaridis and Kitsios, 2023).

This study aims to construct a digital transformation framework in entrepreneurship education and solve following research questions:

1) What are the research themes of entrepreneurship education digital transformation?
2) What theory can improve the validity of the research?
3) What are the dimensions that affect digital transformation framework of entrepreneurship education?

The researchers first examine digital entrepreneurship education publications to identify the key research priorities and construct a conceptual framework. Using theory triangulation, the researchers test conceptual framework based on the entrepreneurship education ecosystem and education digital transformation framework to improve its construct validity. The framework would not only enrich the research on digital entrepreneurship education but also provide guidelines for digital transformation in entrepreneurial education in higher education institutions.

2. Methodology

The research aims to answer research question 1 through systematic literature review and VOS viewer. The systematic literature review is to examine the existing literature related to the main research question of digital entrepreneurship education and construct a conceptual framework. Theoretical triangulation is to improve the construct validity of the conceptual framework, addressing research question 2. And after the theory triangulation, the researchers finalized the factors that affect the entrepreneurship education digital transformation and give answers to research question 3.

2.1. The systematic literature review

The researchers conducted a search for articles on Scopus and Web of Science in January 2024. These two databases are commonly utilized for ranking journals based on their output and the total number of citations they receive, reflecting the impact, prestige, and influence of the journals (Chadegani et al., 2013). To align with the research objectives, the study employed the search term “digital*AND entrepre* AND education” To broaden the search and capture relevant articles on the topic, the researchers utilized an asterisk (*) as a wild card which allows s a more inclusive search by identifying words that share the same letters. Specifically, entrepre* aims to encompass words such as entrepreneurship, entrepreneur, and entrepreneurial, while “digital*” encompasses terms like digitalize or digitalization.

The researchers coordinated with an associate professor in entrepreneurship education to set inclusion and exclusion criteria, which is shown in **Table 1**. Based on

Sitaridis and Kitsios (2023) and Fellnhofer (2019), digital entrepreneurship education did not begin to undergo rapid development until 2018, but there is very few research, so the researchers decided to examine the literature from 2019 to 2023.

Table 1. The standards for searching including and excluding.

Criteria	Inclusion	Exclusion
Language	English	Studies other than English
Time frame	2019–2023	Documents before 2019
Publication	Articles	Other papers, books, reviews
Database	Web of Science and Scopus	Other databases
Sample	High education institutions	Other than high education institutions
Research area	Educational Research	Other than educational research

Initially, under the inclusion and exclusion criteria, there were 86 articles included (**Figure 1**). After the removal of duplicate papers (n = 5), unrelated papers based on title (n = 18), unrelated papers not in high education institutions (n = 2), and without full text (n = 8), there are 53 papers left. Two researchers read the abstracts of 53 articles independently and removed 15 papers unrelated to the research topic. To make sure the quality of the documents, the researchers delete the paper with citation counts below 5 (n = 8). To improve the breadth of literature, the researchers did backwards and forward reference searches (n = 10) and added articles recommended by other researchers (n = 8). At last, the study included 48 publications.

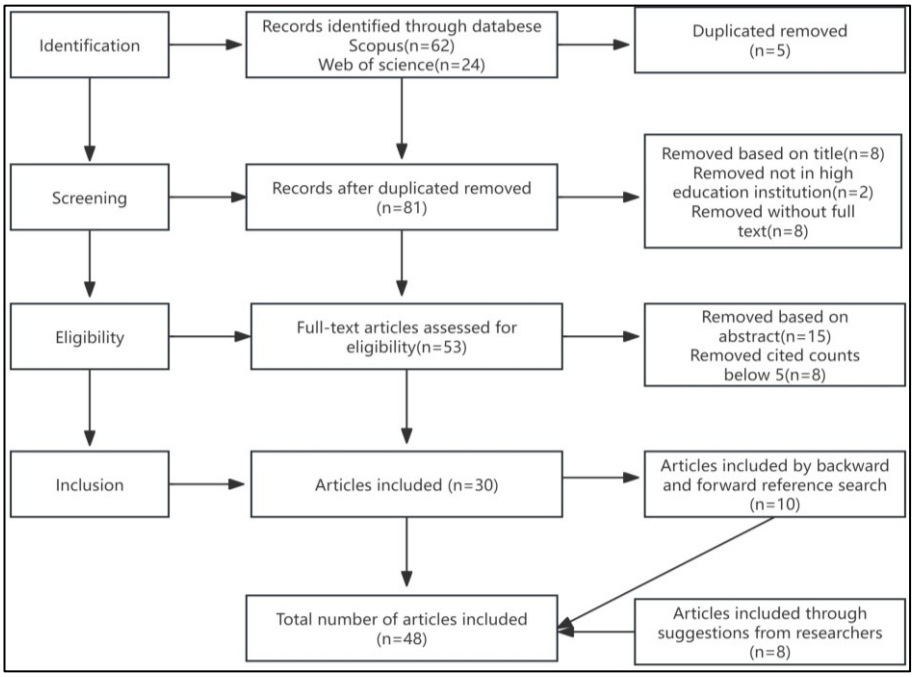

Figure 1. Flowchart diagram of the screening and selection procedure.

Figure 2 illustrates the number of publications produced each year from 2019 to 2023. A Due to the impact of the COVID-19 pandemic, research on digital technology in entrepreneurship education increased rapidly from 2019 to 2020 which reached its highest point in 2020 and then began to decline. From 2022 on, there has been a

continuous upward trend in the number of publications, which increased to 11 in 2023.

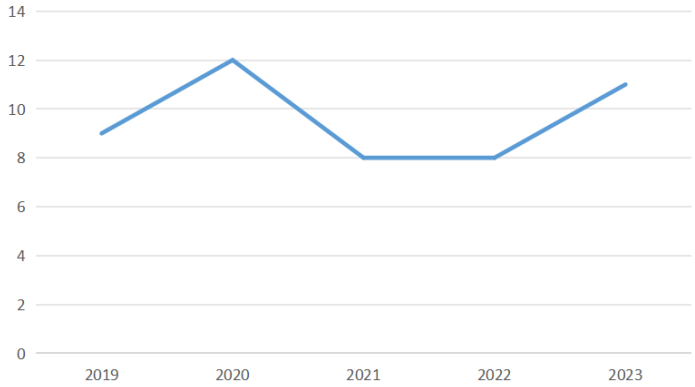

Figure 2. Annual number of publications.

VOS viewer is used for creating maps based on bibliometric data, which helps visualize and understand the relationships between different research areas, concepts, or the centrality and connections between various terms within a body of literature. Almost all the documents related to key terms such as "digital entrepreneurship education," and "higher education" from 2019 to 2023 were used to visualize or map to help understanding the relationships (**Figure 3**).

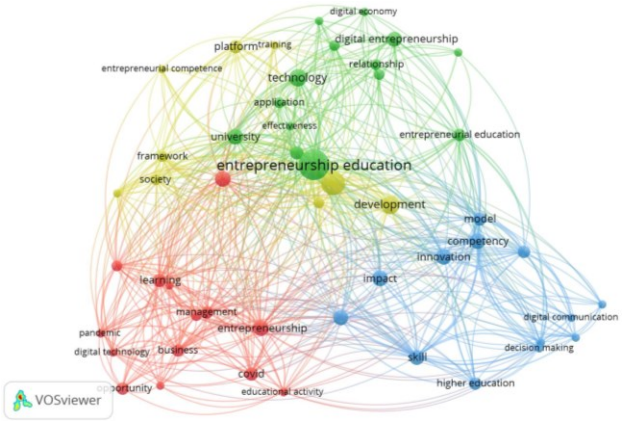

Figure 3. Visualization of a thematic analysis.

Some of the prominent terms in the visualization including "entrepreneurship education" "digital entrepreneurship" "technology" and "digital economy" suggest that the analysis focuses on how digital technologies and digital entrepreneurship are influencing educational practices. Blue Cluster including terms around "competency" "skill" "innovation" "impact" and "higher education" suggest a focus on the impact of digital technologies on cultivating the entrepreneurship skills in colleges and universities. Red Cluster emphasizes the opportunity and challenge the COVID-19 has brought to entrepreneurship education, including "learning" "management" and "digital technology". And yellow cluster indicates that the analysis may also be considering broader socio-economic factors and regional development.

2.2. Theory triangulation

Triangulation in qualitative research is the use of various data sources, data

collection and analysis techniques, participant or researcher viewpoints, or theoretical frameworks to explore the same problem (Nancy et al., 2014). By comparing several data types, triangulation aims to maximize the research's validity, reliability and trustworthiness in order to avoid singular or subjective interpretations (Noble and Heale, 2019). Triangulation is the soundest strategy of theory construction (Denzin, 2009). The study will use two theoretical frameworks (the Entrepreneurship Education Ecosystem and Education Digital Transformation Framework) to triangulate the entrepreneurship education digital transformation conceptual framework to improve the construct validity (**Figure 4**).

The entrepreneurial education ecosystem is composed of entrepreneurship curriculum, students, teachers, school entrepreneurial education environment and social entrepreneurial environment (Brush, 2021; Liu et al., 2021), having characteristics of being self-organized, dynamic and interdependent organic (Maritz and Foley, 2018). Liu et al. (2021) stressed that the innovation and teaching subsystem, support subsystem and operation subsystems make up the Entrepreneurship Education Ecosystem. Teaching and innovation subsystem is the core of the ecosystem, which includes teachers, core faculty, students, entrepreneurial practice programs and entrepreneurship curriculum. The support subsystem comprises leadership strategy, teaching resources, and the cooperation from government, community, and industry. The operation subsystem contains the organization structure and the operation mechanism, which ensure the everyday operation of entrepreneurship education. This study employs the Entrepreneurship Education Ecosystem which covers all the elements of Entrepreneurship Education.

As a guiding framework, the education digital transformation framework can aid higher education institutions in the transition to a digital world (Durek et al., 2018; Nina et al., 2017; Zhu et al., 2022). The framework released by United Nations Educational (2022) comprises six dimensions: strategies and assistance, academic program methods development of curriculum and delivery, teachers' qualified skills, students and how they learn, and quality assurance in education and instruction. This study adopts the framework for digital transformation in education proposed by United Nations Educational, Scientific and Cultural Organization because it is authoritative and encompasses all dimensions of digital transformation in education.

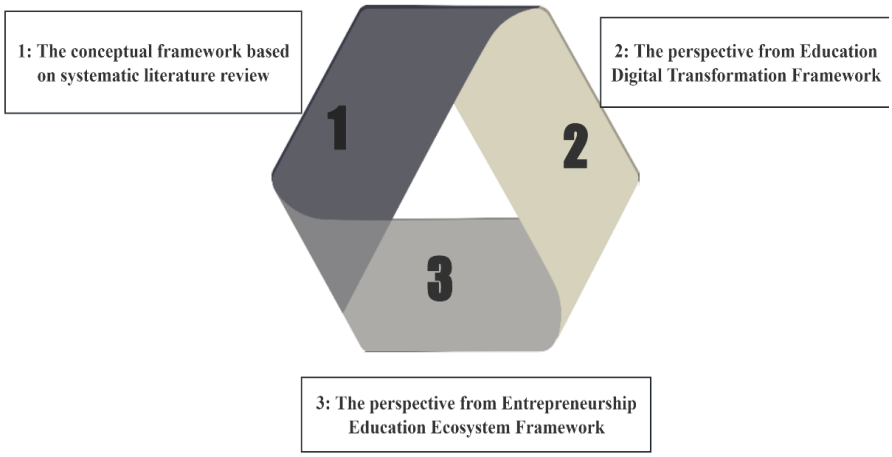

Figure 4. The instruction of theory triangulation.

3. Results

3.1. Conceptual framework for entrepreneurship education digital transformation

After reading full text of these articles, the two researchers categorized them through thematic analysis. To establish interrater reliability, the researchers performed code consistency check. According to code consistency checking formula (Xu, 2005), code consistency = 2*M*/*N*1 + *N*2 (*M* stands for the number of identical codes, *N1* is the number of code of the first coder, *N*2 is the number of code of the second coder). The code consistency of two researchers is 91%, showing high level of agreement.

Figure 5 identifies the dimensions of digital entrepreneurship education, including digital teaching platforms, teachers' digital literacy, digital entrepreneurship pedagogy, students' digital entrepreneurship competence and teaching evaluation and monitoring. The following presents how these dimensions are constituted.

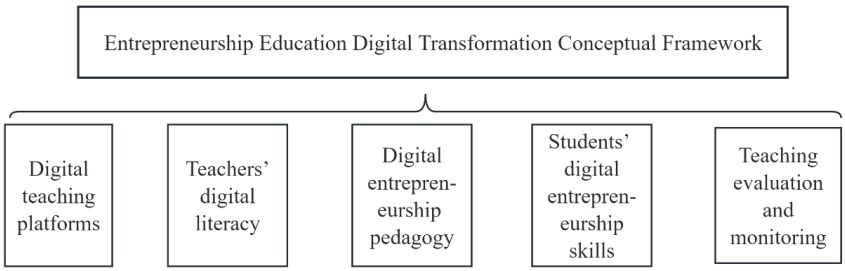

Figure 5. The entrepreneurship education digital transformation conceptual framework.

Digital teaching platforms for entrepreneurship education: After the COVID-19 epidemic, there is a heightened focus on entrepreneurship education digital platforms (Giustina et al., 2021; Liguori and Winkler, 2020; Polbitsyn et al., 2020). Universities should use digital technology to develop teaching and practice platforms (Secundo et al., 2020). Mobile learning not only enhances the effectiveness of entrepreneurship education (Tretyakova et al., 2021), but also aids students in successfully developing entrepreneurial competencies (Silva and Klein, 2020). It is also highly recognized by entrepreneurship teachers (Teymurova et al., 2020). Technology has made entrepreneurship education much more convenient, including the ability to monitor students' learning data (Kaminskiene et al., 2023; Wu et al., 2019), eliminate time and space restrictions (Vorbach et al., 2019), and stimulate students' interest in learning (Hamburg et al., 2019).

Entrepreneurship teachers' digital literacy: In the digital era, students would find it quite appealing to use digital-based learning, so the digital literacy of entrepreneurial teachers is an essential prerequisite for delivering digital entrepreneurship education (Mavlutova et al., 2020). Kaewsaeng-on et al. (2022) stresses that entrepreneurial teachers must employ technology and innovation to improve their teaching. With the rapid development of digital technology, entrepreneurs would face more challenges and entrepreneurial teachers should pay more attention to entrepreneurs' affective domain. It is necessary to cultivate the perseverance in the challenging environment (Wu et al., 2019). Digital entrepreneurs

also emphasize the necessity to increase education in practical entrepreneurial skills and enhance communication between colleges, government, and businesses (Vinogradova et al., 2019).

Pedagogy of digital entrepreneurship: Digital entrepreneurship education requires the integration of digital technologies into instructional design. Bagheri et al. (2019) stressed the effect of game-based learning in entrepreneurship education, and they found that students were interested in gamification. Portuguez Castro and Gómez Zermeño (2020) proposed to innovate education based on technologies and developed an e-learning educational model to cultivate the entrepreneurial spirit. Some researchers reformed the entrepreneurship teaching model using technologies like 5G fog computing technology (Liu et al., 2021). Entrepreneurship courses should focus on new business models, computer thinking and a holistic approach to problem-solving (Kang and Lee, 2020).

Competence of digital entrepreneurship: The study conducted by Young et al. (2020) revealed a direct correlation between digital literacy, learning aptitude, and the level of success achieved in digital entrepreneurship. Paz et al. (2021) developed an EmDigital model by combining digital literacy and entrepreneurship skills. Social media competency and digital marketing skills have a significant influence on choosing entrepreneurial opportunities (Nam and Xiong, 2021; Papageorgiou et al., 2021). The development of self-efficacy in the digital economy era has a direct effect on influencing entrepreneurial personality (Gumbi and Westhuizen, 2020; Kholifah et al., 2022). Apart from that, skills such as being open to novelty, creating solutions to emerging problems, prior knowledge, entrepreneurial alertness and leadership are also considered basic skills for digital entrepreneurship (Dieguez et al., 2021; Jardim, 2021; Nam and Xiong, 2021).

Monitoring and evaluation of teaching effectiveness: Students' willingness to participate in digital entrepreneurship is an indicator of entrepreneurial education effectiveness. The perceptions of information and communications technology (ICT) usefulness in entrepreneurship courses moderate the relationship between entrepreneurial attitudes and risk (Bandera et al., 2018). Artificial Intelligence (AI) in entrepreneurship education positively affects entrepreneurial intentions (Dabbous and Boustani, 2023). Module-assisted learning can help to improve students' entrepreneurial attitudes rather than their entrepreneurial intentions (Wahidmurni et al., 2022). Classroom Response Systems technology (Wu et al., 2019), Eye-Tracking Technology (Kaminskiene et al., 2023) and a neural network evaluation model (Huang et al., 2019) have been used to investigate the entrepreneurship education learning process.

3.2. Comparative and synthesized findings by theory triangulation

Generally, there are two different tendencies in research on theory triangulation (O'Brien, 1993): One focuses on the convergence of research results, and the other emphasizes the complementarity of research outcomes (Erzberger and Prein 1997; Van Drie and Dekker 2013). On one hand, convergence primarily involves analyzing the same content through multiple methods or theories and has limited support for qualitative research (Denzin, 2009). On the other hand, complementary triangulation

aims to enhance the interpretation of practical problems from various theoretical perspectives, making research results more representative and providing a holistic perspective (Flick, 2017).

The objective of this study is to provide a comprehensive framework for entrepreneurial education digital transformation. This study is exploratory because there is a scarcity of research and empirical evidence on the topic in the available literature. Therefore, this study adopts a complementary theory triangulation. The conceptual framework dimension is tested and expanded by incorporating different theoretical perspectives.

This study employs a three-step approach to construct the framework on digital entrepreneurship education (**Figure 6**). At the first step, the researchers initiated the research by constructing a conceptual framework on the basis of existing literature. The initial phase revealed that digital entrepreneurship education encompasses digital instructional platforms, teachers' digital literacy, pedagogy, students' digital literacy, and teaching evaluation and supervision.

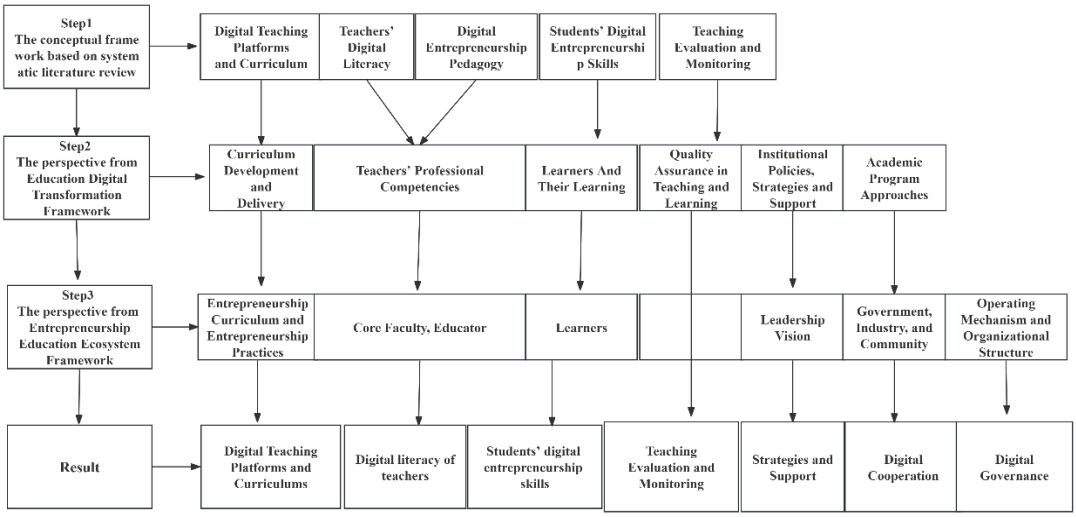

Figure 6. The process of complementary theory triangulation.

At the second step, the conceptual framework was enriched from the perspective of the Education Digital Transformation Framework. Based on this theory, except for the five dimensions, the dimensions should also include institutional strategies and academic program approaches. In the digital transformation process in education, strategies stand for leadership, the guideline for developing entrepreneurship education (Zhu et al., 2022). Entrepreneurship education has close relationships with society and government, even many entrepreneurship practice programs are developed with the support of government and society (Brush, 2021; Liu et al., 2021), so these two dimensions need to be added into the framework. Teachers' digital literacy and digital entrepreneurship pedagogy are merged into teachers' professional competencies, so the second version of the framework has six dimensions.

At the third step, the second iteration of the framework was further enhanced with an explicit focus on the ecosystem framework for entrepreneurship education. The ecosystem framework introduced operational mechanisms and organizational structures in contrast to the preceding aspects (Brush, 2021). Due to the growing

influence of entrepreneurship education on society and the economy, an increasing number of universities have established organizations dedicated to entrepreneurship education, competitions, project incubation, and collaboration with the community (Liu et al., 2021). Hence, the framework should have functional mechanisms and organizational structures.

3.3. The final digital transformation framework in entrepreneurship education

Since then, the entrepreneurship education digital transformation framework has been finalized and contains a total of seven dimensions (**Table 2**), namely: Strategies and Support, Digital Teaching Platforms and Curriculums, Digital literacy of teachers, Students' digital entrepreneurship skills, Teaching Evaluation and Monitoring, Digital Cooperation, and Digital Governance.

Table 2. The entrepreneurship education digital transformation framework.

Dimensions	Description
Strategies and Support	Clear goals and specific action plans for entrepreneurship education digital transformation.
Digital Teaching Platforms and Curriculums	Digital entrepreneurship curriculums, entrepreneurship practices, and digital platforms providing educational resource allocation and teaching resource service.
Digital literacy of teachers	Entrepreneurship teachers' knowledge, attitudes, and abilities in applying digital teaching and learning.
Students' digital entrepreneurship skills	Entrepreneurial students' perceived, cognitive and executive skills in digital entrepreneurship.
Teaching Evaluation and Monitoring	Monitoring and evaluating the process and effects of entrepreneurship education using digital technologies.
Digital Cooperation	Collaborating with the businesses or community to develop digital entrepreneurship curriculums and Practices programs.
Digital Governance	Organization structure and operation mechanism on entrepreneurship education.

4. Discussion

4.1. The main factors promoting the digital transformation of entrepreneurship education

The differences between digital entrepreneurship and traditional entrepreneurship force entrepreneurship education to change. The digital economy has infiltrated into all aspects of production and life in the era of industry 4.0. According to a report released by World Economic Forum (Jacobides et al., 2019), our daily lives, as well as our experiences as consumers, workers, community members, and citizens, are already dominated by digital platform models. As digital economy provides more opportunities for entrepreneurship, digital entrepreneurship is arising. Hull (2007) defines digital entrepreneurship as a category of entrepreneurship in which part or all of the physical elements of a typical organization are digital. They also describe how digital marketing, sales, products, distribution, stakeholder management, and operations have changed. Nambisan (2017) assumes that digital technology changes the uncertainty inherent in entrepreneurship processes and effects and the ways utilized to cope with it. Therefore, significant differences between digital and traditional entrepreneurship should be taken into account during the process of

entrepreneurship education in universities.

Digital transformation is an inevitable choice for educational institutions to meet the requirements of future social development. The digital transformation of education is an epoch-making systematic process that integrates digital technologies into all levels of the educational field. The digital transformation of education can promote all-around innovation and change in the teaching paradigm, organizational structure, learning processes, and evaluation methods (Pelletier et al., 2023; Zhu et al., 2022). However, digital entrepreneurship education has yet to develop a unified concept. To sum up, digital entrepreneurship education is an extensive reorganization of the entrepreneurship education teaching content, pedagogics, and effectiveness evaluation by entrepreneurship educators who use digital technology to improve students' digital entrepreneurship skills.

4.2. The suggestions for the entrepreneurship education digital transformation

In the context of digital transformation of global education, entrepreneurship education, as an essential element of higher education, must make timely adjustments. According to the literature analysis on the digital transformation of entrepreneurship education, the existing research mainly focus on analyzing students' digital entrepreneurship ability, the practice platform, the digital reform of entrepreneurship education classrooms, and other partial influencing factors. However, digital transformation of entrepreneurship education is a gradual, all-encompassing process, including macro-policies, teacher digital literacy, students' entrepreneurial competence, teaching content, pedagogics, evaluation of effectiveness, social co-operation, and entrepreneurial culture. It is necessary to carry out a systematic and holistic design from the perspective of institutional mechanisms, management mode, and teaching mode. Higher education institutions need to determine the deficiencies of each element of digital entrepreneurship education and the direction for improvement. So, it is expected to become a significant research trend in the holistic planning and evaluation for digital transformation of entrepreneurship education.

4.3. The value of the digital transformation framework in entrepreneurship education

Although many researchers have paid attention to the great changes that digital economy and digital education have brought to entrepreneurship education, the research appears to be more fragmented. Under the background of digital transformation of education, this study constructs the framework of digital transformation of entrepreneurship education from the overall perspective. This framework is innovative in theory and practice. Theoretically, this framework is the first attempt to research entrepreneurship education digital transformation from a holistic perspective. Based on the framework, entrepreneurship education digital transformation should be carried out in seven dimensions: systematic design, digital literacy of entrepreneurship education teachers, students' digital entrepreneurship ability, digital entrepreneurship education courses, digital foundation in colleges, digital evaluation of teaching and learning and digital regional cooperation. On a

practical level, the framework provides a roadmap for digital transformation of entrepreneurship education, which can aid colleges and universities improve the effectiveness of entrepreneurship education.

5. Conclusion and limitation

This paper systematically analyzes 48 articles on digital entrepreneurship education between 2019 and 2023. A conceptual framework of entrepreneurship education digital transformation conceptual framework is constructed, which contains five dimensions: digital teaching resources, digital teaching methods, teachers' digital literacy, students' digital entrepreneurship ability, and assessment of teaching effect. In order to improve the construct validity of the framework, this paper adopts the method of theory triangulation, using the entrepreneurship education ecosystem theory framework of and the education digital transformation framework to validate the conceptual framework and supplement it. At last, the digital transformation framework for entrepreneurship education contains seven dimensions: strategies and support, digital teaching platforms and curriculums, digital literacy of teachers, students' digital entrepreneurship skills, teaching evaluation and monitoring, digital cooperation, and digital governance.

The entrepreneurship education digital transformation framework proposed in this paper can theoretically fill a gap in existing research on the digital transformation of entrepreneurship education. In practice, it can provide colleges with a reference for the digital transformation of entrepreneurship education. But there is still room for improvement in this study. Although this study has validated the construct validity of the framework through the application of theory triangulation, it still needs validation of feasibility and generalization. And the researchers need more empirical validation for the framework. The framework should be further tested by Delphi method and practical applications.

Author contributions: Conceptualization, CZ and MR; methodology, CZ; validation, CZ; formal analysis, CZ; resources, CZ; writing—original draft preparation, CZ; writing—review and editing, MR; visualization, MR; supervision, MR. All authors have read and agreed to the published version of the manuscript.

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