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Integrating Entrepreneurial Education into STEM Education: A Systematic Review

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Abstract
The integration of entrepreneurship education and STEM education has emerged as a crucial field of research, necessitating an immediate providing a comprehensive review of the field from diverse viewpoints, thereby supporting upcoming research projects. This systematic review aimed to address the following three research questions: What are the characteristics and trends of the current studies on integrating entrepreneurial education into STEM education? (RQ1); Based on the extent of integration, what are the types of integration of entrepreneurial education into STEM education? (RQ2); Following an in-depth analysis and overview of each type, what are the corresponding patterns for each type of integration of entrepreneurial education into STEM education? (RQ3). Utilizing the PRISMA procedure's criteria, we pinpointed 31 eligible articles. Reacting to RQ1, a descriptive analysis has been conducted to provide a comprehensive description of the publication year, the first author's nation, research methods, participants, and impact. Reacting to RQ2, we conducted an in-depth content analysis and categorized entrepreneurial STEM education into three distinct types: the entrepreneurial element-embedded design, the whole-process integration, and the project-driven entrepreneurial design. Reacting to RQ3, the flowcharts provided for each type offer a practical template for understanding the patterns of integration. The Type I pattern shows entrepreneurship as an additional component to the STEM curriculum, the Type II pattern illustrates a more integrated approach throughout the educational process, and the Type III pattern displays a project-driven, in-depth integration of entrepreneurship.

Keywords Entrepreneurial education · STEM education · Integration · Systematic review

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Introduction

Entrepreneurial education has emerged as a pivotal force in shaping the future workforce, with its capacity to instill 21st-century skills and competencies essential for employment and personal growth(Alvarez & Barney, 2007; Jang, 2016). In the rapidly evolving landscape of global economics and technological innovation, Science, Technology, Engineering, and Math (STEM) education can foster students' comprehensive literacy and enhance their global competitiveness, which is seen as the key to future economic prosperity (Panizzon & Corrigan, 2017). STEM education and entrepreneurial education are both important interdisciplinary fields, and the integration of the two will undoubtedly bring higher individual and social value (Deveci & Seikkula-Leino, 2023; Kaya-Capocci & Ucar, 2023).

UNESCO-UNEVOC believes that entrepreneurial learning offers a realistic and effective means to develop the transferable skills needed to succeed in the 21st century, with leaders and practitioners of TVET institutions having a crucial role to play. Innovation and Entrepreneurship are important tools for industrial and economic development, and any means of integrating them through science, technology, engineering and mathematics education must be strongly advocated. Integrating aspects of innovation and entrepreneurship into college and university curricula, along with the training and retraining of innovators and entrepreneurs, are strategies to transform the results of science, technology, engineering, and mathematics education into valuable resources for worldwide industrialization (Akinoso et al., 2012). Entrepreneurial STEM education can foster students' entrepreneurial thinking, cultivate creativity, actualize personal potential, and have a significant positive impact on society (Kaya-Capocci & Ucar, 2023; Wilson et al., 2009). However, the number of studies integrating entrepreneurial education into STEM education remains limited. There is also a lack of clear understanding of how entrepreneurial education and STEM education should be linked (Panizzon & Corrigan, 2017). However, to achieve a deeper comprehension of this integration, it is essential to delineate several key research questions: What are the characteristics and trends in current studies integrating Entrepreneurial Education into STEM Education? What types of integration exist based on the extent of integration? And what patterns correspond to each type of integration? This systematic review aims to address these research questions, providing support for upcoming research initiatives.

Literature Review

In recent years, with the rapid development of science and technology, the country's needs for economic growth have changed fundamentally. This has led to significant increases in unemployment in many developed and developing countries. Because of this situation, many countries around the world, in particular Turkey and France, have begun to incorporate the concept of "entrepreneurship" into their educational programmes (European Commission, 2011, 2013). Entrepreneurship can be learned and taught (Kuratko, 2005), while entrepreneurial education provides students with entrepreneurial knowledge and skills training, and encourages positive attitudes towards entrepreneurship (Cho & Lee, 2018). At the same time, entrepreneurship education focuses on cultivating students' multifaceted, interdisciplinary competencies, and training students to become entrepreneurs and excellent self-starters (Sudarmin et al., 2023).

Present-day academics characterize entrepreneurship through three primary lenses. Some studies viewed entrepreneurship as a process. Allen and Stearns (2003) described entrepreneurship as an organizational process encompassing resource investment, procedure establishment, resource identification, assembly, and configuration; along with human interaction, coordination, and routine establishment. Some perceived it as a competence. Timmons (1989) argued that entrepreneurship was the ability to create and establish something from scratch. There's also a contention regarding the complexity of entrepreneurship. Entrepreneurship is defined as a way of thinking and behaving that is relevant to both society and the broader economy, including business acumen and initiating new business (Herrmann et al., 2008). Scholars have varied interpretations of entrepreneurship, yet unanimously agree on its significance and essential role in contemporary society, exhibiting a pattern of merging while preserving its distinct features.

Entrepreneurial and STEM education share a tight bond, being mutually beneficial and reinforcing. It's broadly acknowledged that both entrepreneurship and STEM education have commonalities, particularly in their focus on practical application, fostering creative thinking, and interdisciplinary integration. However, it's important to recognise that Deveci and Seikkula-Leino (2023) pointed out the unique skills and competencies offered by the STEM workforce are absent in conventional education. This is partly because conventional teaching methods typically emphasize passive learning, in contrast to non-traditional fields like entrepreneurship which necessitate a more engaged learning process (González et al., 2019). In this sense, the adoption of student-centered active learning methods in STEM education creates another suitable application field for entrepreneurship education.

Additionally, the use of experiential learning methods in both STEM and entrepreneurship education can be seen as another advantage. It has been established that experiential learning through competency-based practice is a good way for high school students to adopt an interdisciplinary E-STEM model (Eltanahy et al., 2020). Studies have shown that integrating experiential entrepreneurship into engineering design can foster entrepreneurial awareness among students (Kaya-Capocci & Peters-Burton, 2023; Olawale et al., 2020). On the other hand, entrepreneurship education and STEM education serve as synergistic elements. STEM education is an interdisciplinary approach focusing on teaching different disciplines or subject knowledge from STEM disciplines to address practical issues in a student-centered environment (Capraro & Slough, 2013). Developing ideas or products (business or social projects) that have the potential to create value in everyday life requires an entrepreneurial mindset (Deveci & Seikkula-Leino, 2023). It is generally agreed that entrepreneurship education, particularly in STEM disciplines, should integrate an understanding and consciousness of the commercialization process (Phillips, 2010; Rasmussen, 2005). Entrepreneurship education emphasizes cultivating creative thinking and problem-solving abilities and can provide a foundation for advancing STEM education via partnerships between universities and enterprises. In conclusion, there are many studies advocating that STEM education and entrepreneurship education should be integrated or executed jointly.

Integrating entrepreneurship education into STEM education offers a comprehensive learning journey, enhancing students' creative and practical abilities, thereby preparing them more effectively for upcoming social and professional growth requirements. Additionally, entrepreneurial STEM education holds significant promise in enhancing the educational results and learning of students (Eltanahy et al., 2020; Mwasiaji et al., 2022). Current research predominantly concentrates on the abilities students acquire through the amalgamation of integrating entrepreneurial education into STEM education. From the perspective of knowledge, integrating entrepreneurial education into STEM education associated with students to structure ideas, integrate knowledge from different disciplines, and facilitate the educational results of entrepreneurial activities(Eltanahy et al., 2020); From a skill standpoint, integrating entrepreneurial education into STEM education can amplify STEM education's influence, bolster communication skills, resilience, autonomy, teamwork, and identify business opportunities (Dahl & Grunwald, 2022; Eltanahy et al., 2020; Yazıcı et al., 2023). Viewing from an attitude standpoint, integrating entrepreneurial education into STEM education boosts problem-solving skills, entrepreneurial intention, self-efficacy, interest in STEM careers, confidence, and more (Ahmad & Siew, 2022; Elliott et al., 2020; Eltanahy et al., 2020; Shahin et al., 2021; Strimel et al., 2019; Yazıcı et al., 2023). It is evident that at the individual level, we can foster the enhancement of students' knowledge, skills, and emotional attitudes. Furthermore, enhancing cross-disciplinary collaboration and fostering cross-disciplinary dialogue at the team level are crucial competencies for the 21st century.

In integrating entrepreneurship education into STEM education, researchers vary in their focus on integration Some scholars have concentrated on integrating the entrepreneurial process into STEM learning and created diverse patterns and frameworks. For example, Xu et al. (2019) proposed a framework for STEM-ET vision and a program for professional learning aimed at boosting teachers' capacity to nurture entrepreneurial STEM; Eltanahy et al. (2020) organized an E-STEM model for incorporating entrepreneurial practices into STEM education; Dahl and Grunwald (2022) promoted the deployment of entrepreneurial products through STEM competitions; Shahin et al. (2021) incorporated the entrepreneurial process into their problem-solving journey through the OzGirls STEM-based entrepreneurial strategy. Yazıcı et al. (2023) integrated 6E learning byDeSIGN™ to enhance entrepreneurial skills among middle school students. It's evident that the types of integrating entrepreneurial education into STEM education vary, and the aspects of students' capabilities are not consistent. There are still deficiencies in the conducted studies, necessitating an immediate comprehensive review to fully understand the circumstances in this field. Initially, we will explore the characteristics and trends of current research integrating entrepreneurial education into STEM education. This includes an analysis of the publication year, the first author's country, research methods, participants, and impact. This descriptive analysis will provide a holistic view, assisting in understanding the trajectory of the field. Subsequently, we will conduct an in-depth content analysis and categorization of the types of integration of Entrepreneurial Education into STEM Education based on the extent of integration. Finally, we will provide practical templates for understanding the patterns of integration for each type through flowcharts. These visual representations will aid in clearly comprehending the characteristics and patterns of each integration type.

Research Questions

The objective of this systematic review is to outline the impact of integrating entrepreneurial education into STEM education and identify possible research avenues. To address these objectives, the study is steered by the following three research questions (RQs):

RQ1 What are the characteristics and trends of the current studies on integration of entrepreneurial education into STEM education?

RQ2 Based on the extent of integration, what are the types of integration of entrepreneurial education into STEM education?

RQ3 Following an in-depth analysis and overview of each type, what are the corresponding patterns for each type of integration of entrepreneurial education into STEM education?

Research Methods

In tackling these three research questions, the PRISMA guidelines and selection process (Moher et al., 2009) were employed to pinpoint relevant literature. It is advised to employ PRISMA statements in systematic reviews to enhance the reader's comprehension of the selection procedure (Moher et al., 2009). Additionally, systematic reviews frequently exhibit bias during the selection phase, necessitating a clear and transparent selection procedure to prevent such bias (Knobloch et al., 2011). PRISMA is an evidencebased minimum set of items for reporting in systematic reviews and can provide the basis for reporting templates (Li et al., 2022). Consequently, employing PRISMA could improve the quality of systematic review reports and provide considerable transparency in the selection of systematic review papers (Knobloch et al., 2011). PRISMA frequently serves to encapsulate various patterns and procedures across multiple disciplines, so this study also employed PRISMA for categorizing patterns. Figure 1 offers an overview of the study's flow diagram.

Search Procedures

In conducting this systematic review, we adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) standards (Moher et al., 2009) to steer our search approach (see Fig. 1). The procedure involves four phases: identification of primary search terms and search strings, database search and additional sources, preliminary literature screening, and full-text assessment for eligibility.

Identification of Primary Search Terms and Search Strings

Guided by the goal of encompassing the maximum number of relevant articles, and following three group discussions, the two researchers identified two main search terms: "STEM education" and "Entrepreneurial education", subsequently creating a compilation of synonyms and alternative terms through an examination of earlier essential literature (see Table 1). Then, we employed these search terms: ("STEM" OR "STEM education" OR "Science, technology, engineering, mathematics") AND ("Entrepreneur" OR "Entrepreneurial" OR "Entrepreneurship" OR "Entrepreneur education").

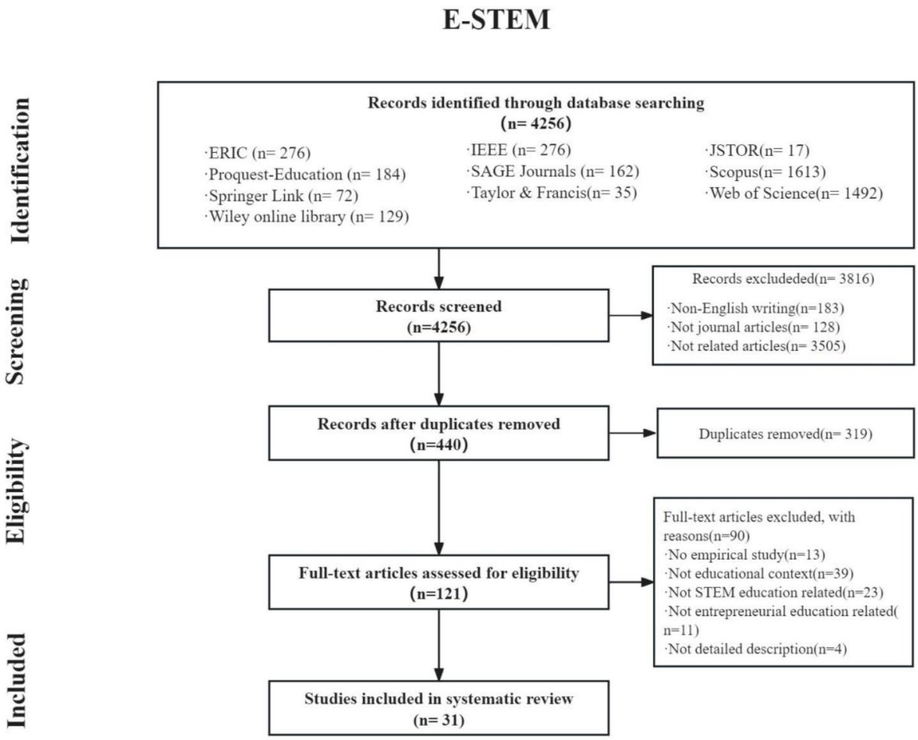

Fig. 1 The flow diagram in this study adapted from PRISMA (updated on 15 February 2024)

Table 1 List of search terms and search strings

Major search terms	Synonyms and alternative terms	Search strings
STEM education	STEM; STEM education; Science, technology, engineering, mathematics;	"STEM" OR "STEM education" OR "Science, technology, engineering, mathematics"
AND		
Entrepreneurial education	Entrepreneur; Entrepreneurial; Entrepreneurship; Entrepreneurial education;	"Entrepreneur" OR "Entrepreneurial" OR "Entrepreneurship" OR "Entrepreneur education"

Database Search

Ten databases with relevant and high-quality papers were identified as the main sources of literature, including ERIC, IEEE, JSTOR, ProQuest, SAGE Journals, Scopus, Springer Link, Taylor & Francis, Web of Science, and Wiley Online Library (see Fig. 1). During the search period, a commencement date wasn't specified, with the deadline set at 15 February 2024, and it was discovered that the initial empirical studies in this field commenced in 2012. A comprehensive search of these databases yielded a total of 4256 records. During this procedure, the pair of researchers independently examined the database, subsequently collaborating to deliberate on the discrepancy and conclude the article count.

Preliminary Literature Screening and Exclusion Criteria

This phase consists mainly of screening the titles, abstracts, and keywords of the searched literature. The initial screening of literature was based on three criteria: (a) Not journal articles ($n=128$), including book chapters, conference papers and minutes, newspapers, company news, brief communications, official documents, working papers, and dissertations for thorough academic analysis and systematic review compliance; This study is going to examine the article in depth. Journal articles usually require authors to provide detailed research background, methodology, data analysis and discussion, which helps us to fully understand the research process and summarise and analyse it. In contrast, book chapters and conference papers are often limited in length and may not provide sufficient detail to illustrate the full empirical research process. Therefore, we chose journal articles as the main data source to make the research result more scientific and reliable. (b) Non-English writing ($n=183$); (c) Not related articles ($n=3505$), pertains to articles unrelated to entrepreneurial STEM education. Of the 4256 searched articles, 3817 were excluded. Following the elimination of 319 duplicates, the remaining 121 articles passed the preliminary literature screening and progressed to the subsequent phase. During this procedure, (a, b) involved researchers individually sifting through each database using self-contained functions, while (c) entailed a rudimentary filtering process, examining titles, abstracts, and so on, followed by inputting the fundamental details of the remaining articles into Microsoft Excel. Given that the articles originated from 10 distinct databases and might have been replicated, Microsoft Excel was used to delete these duplicates.

Full-Text Assessment for Eligibility and Exclusion Criteria

During this phase, 121 articles underwent a full-text assessment for their eligibility. The following four exclusion criteria were used to identify records: (a) Not an empirical study ($n=13$), including literature review articles, theoretical introductions, and only experience sharing; (b) Not related to STEM education ($n=23$); (c) Not related to entrepreneurial education ($n=11$); (d) Not educational context ($n=39$), including teaching in informal settings, such as entrepreneurship training and museum learning. (e) Non-detailed description ($n=4$). In the process, the researchers reviewed each of the 121 articles and discussed them through group exchanges. If there are disagreements between two researchers, a third person is sought to discuss the matter, and when consensus is reached, the article moves on to the next stage. In the end, 90 articles were discarded and 31 were left for the next phase.

Coding Process and Content Analysis

In this phase of systematic review, 31 eligible articles were imported into Microsoft Excel for further coding and organization. Two members of the research team collaboratively analyzed the coding of previous studies and worked together to allocate codes to every article. In instances of uncertainty during the procedure, in-depth discussions were held until a consensus was reached via negotiation (see Table 2).

Table 2 31 articles included in the systematic review

Eligibility no.	Citations
E1	Marin et al. (2023)
E2	Sudarmin et al. (2023)
E3	Lenhart et al. (2023)
E4	Solodikhina and Solodikhina (2022)
E5	Eltanahy and Mansour (2022)
E6	Shahin et al. (2021)
E7	Full et al. (2021)
E8	Treanor et al. (2021)
E9	Martin et al. (2018)
E10	Paço et al. (2017)
E11	Watts and Wray (2012)
E12	Yazıcı et al. (2023)
E13	Doughan and Shahmuradyan (2022)
E14	Wagler (2023)
E15	Rippa et al. (2022)
E16	Primario et al. (2022)
E17	Sari et al. (2022)
E18	Oliver et al. (2019)
E19	Bandera (2022)
E20	Benek and Akçay (2022)
E21	Moore et al. (2017)
E22	Cadenas et al. (2020)
E23	Kukreti and Broering (2019)
E24	Ahmad and Siew (2022)
E25	Strimel et al. (2019)
E26	Pabuçcu Akiş and Demirer (2023)
E27	Arifin and Siew (2023)
E28	Şirin and Çelikkkıran (2021)
E29	Aydın-Günbatar (2020)
E30	Kaya-Capocci et al. (2022)
E31	Dahl and Grunwald (2022)

Results

In response to the three questions posed in this systematic review, a detailed descriptive analysis of these 31 articles was performed to address Q1. Regarding Q2, the articles were divided into three types according to the degree of integration of entrepreneurship education and STEM education through further in-depth analysis of the articles. Pertaining to Q3, the patterns of each type were summarised in the form of flowcharts.

Descriptive and Summative Overview of the Literature

Firstly, the descriptive overview of the selected articles in this review is provided to better understand the research characteristics and trends of integrating entrepreneurial education into STEM education and the relevant characteristics that were extracted, including the year of publication, countries or regions, research methods, and research participants.

Publication Year

Figure 2 displays the number of publications spanning from 2012 to 2023. A significant increase is observed in the number of research papers focusing on entrepreneurial STEM education. Especially remarkable is the span from 2020 to 2022, in which the cumulative research over these three years reached 17, making up 55% of the overall 31 articles. Nonetheless, the reduction in article count in 2023 could stem from the fact that the literature examined in this research dates back to before October 2023, leaving further articles uncovered. Notably, as far back as 2012, several scholars have employed various commercial tools in STEM fields for entrepreneur education at the University [E11]. In a more recent development during August 2023, several academics suggested the R2I2S, which addresses the NRT program goals by building on the Lens of the Market (LoM) program, leading to heightened student curiosity and comprehension of societal and market perspectives pertinent to their and others' studies [E3]. One research conducted in July 2023 facilitated the commercialization and marketing of new technology-based products and services in STEM MBA programs [E1].

Countries

Figure 3 displays the source countries of the selected articles, showing the first author's institution's location, acknowledging that certain articles lacked explicit location details for their research.

The origin of these 31 articles is traced back to research institutions across 13 nations. The U.S.'s research institutions accounted for the majority (36%,11), followed by Turkey's research institutes (19%,6), and then the UK, Malaysia, and Italy (each at 7%, each contributing 2 articles). Generally, the geographical spread of institutions in this area is extensive,

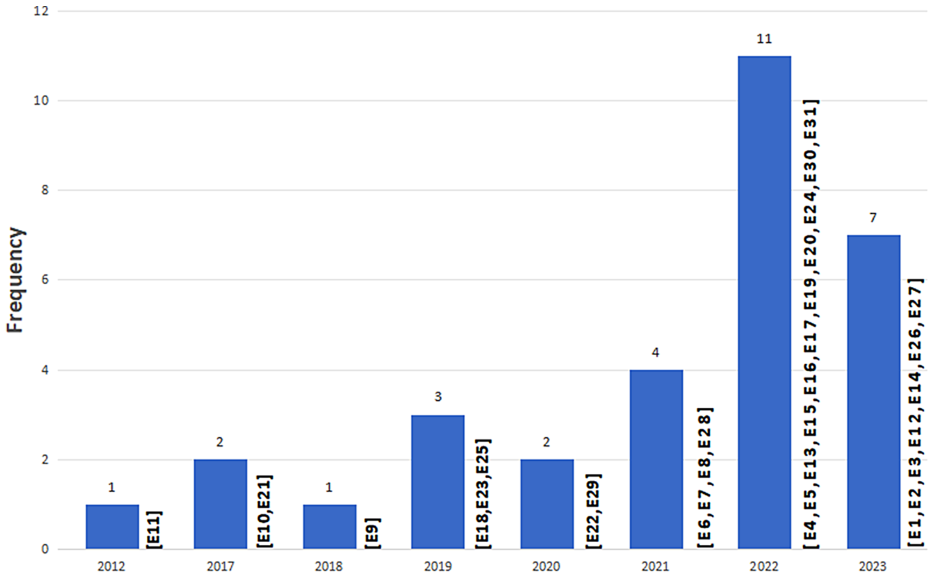

Fig. 2 Number of studies on Entrepreneurial STEM education from 2012 to 2023

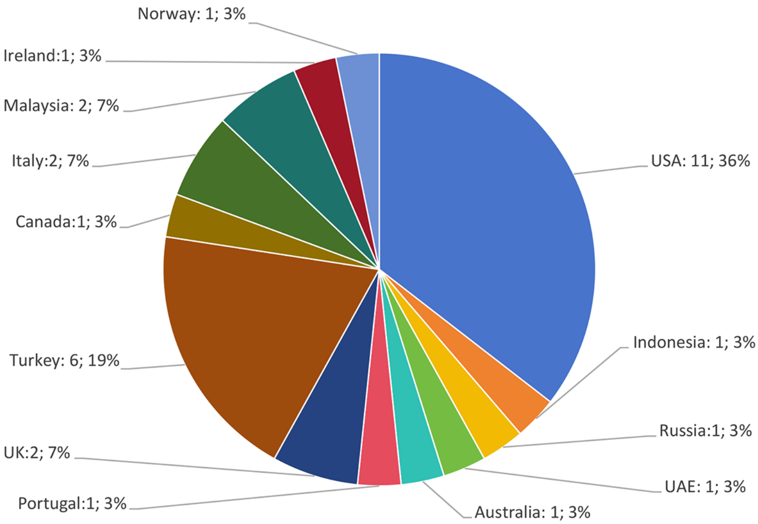

Fig. 3 Countries of the articles

Table 3 List of research methods

Research type	Research method	Frequency	References
Qualitative (58.1%, 18)	Interviewing method	6	[E3, E5, E10, E29, E30, R31]
	Case study	8	[E1, E3, E4, E7, E8, E11, E18, E19]
	Case report	2	[E2, E23]
	Observation method	1	[E5]
	Ethnography	1	[E2]
Quantitative (29.0%, 9)	Questionnaire survey method	2	[E3, E16]
	Experimental method	6	[E6, E13, E14, E22, E24, E29]
	Computational modeling	1	[E25]
Mixed (32.3%, 10)	Mixed research method	10	[E3, E9, E12, E15, E17, E18, E20, E26, E27, E28]

with developed nations or regions holding a greater share compared to their less developed counterparts.

Research Methods

The study conducted a frequency analysis of research types and methods, the results of which are presented in Table 3.

In terms of research methods employed in specific topics, qualitative research accounted for the majority (58.1%), succeeded by mixed-method research (32.3%), and quantitative studies made up the lowest percentage (29.0%). In instances where articles employed multiple research methods such as E3, each method was categorized accordingly, resulting in the overall count of research methods surpassing the aggregate number of articles. Among articles employing qualitative research, case studies topped the list with 8 articles (25.8%), succeeded by the interviewing method, utilized in 6 articles (19.4%). Within quantitative studies, questionnaire surveys were employed in 2 empirical papers (6.5%), while 6 were experimental studies, including both experimental methods and field experiments. Studies employing mixed methods, which involved various combinations of quantitative and qualitative research, accounted for 10 articles.

Research Participants

Table 4 displays the research participants of the eligible articles, with the 31 articles categorized into two industries, namely commerce and education industry. Given that each article could include individuals from various industries and identities within a specific industry, the aggregate participant count surpasses the overall article count, leading to over 100%.

Of the two industries listed in Table 4, the education industry represented the largest share (more than 100%, 51). This is attributed to the fact that the instruction in each article we have selected takes place in the formal learning context with the presence of trainers and trainees. This study further divides the educational industry into students (93.5%, 29) and teachers (74.2%, 23), depending on the characteristics of the participants. At the student level, entrepreneurial STEM education necessitates students to possess specific learning capabilities and fundamental problem-solving skills, leading to the selection of more advanced students for the program. Table 4 reveals that the majority of students are undergraduates (13, 41.9%), succeeded by those in secondary school (11, 35.5%), while postgraduates and doctoral candidates [E3, E10, E15] focus more on their entrepreneurial aspirations and career paths. At the teacher level, entrepreneurial STEM education demands interdisciplinary literacy and abilities in teachers, including those engaged in Chemistry [E2, E13], Biology [E7], and STEM fields. Conversely, in certain research, educators have served as apprentices [E17, E29], enhancing their pedagogical abilities, cross-disciplinary

Table 4 List of research participants

Category	Research participants		Frequency	References
Commerce industry (12)	Business mentors		2	[E4, E8]
	Business consultants		2	[E4, E8]
	Customers		4	[E14, E18, E19, E23]
	Entrepreneurs		4	[E1, E4, E8, E10]
Education industry (51)	Students	Primary school students	1	[E24]
		Middle school students	11	[E4, E5, E6, E12, E20, E25, E26, E27, E28, E31]
		Bachelor	13	[E1, E2, E6, E7, E8, E11, E13, E14, E16, E18, E19, E22, E30]
		Master	2	[E3, E10]
		Doctoral	2	[E3, E15]
	Teachers	Pre-service teachers	2	[E17, E29]
		In-service teachers	16	[E1, E6, E9, E10, E12, E18, E20, E21, E22, E23, E24, E25, E26, E27, E28, E31]
		STEM teachers	2	[E3, E14]
		Chemical teachers	2	[E2, E13]
		Biography teachers	1	[E7]

understanding, business acumen, and so on. Through involvement in the program, they significantly contribute to the development and enhancement of their students.

Undoubtedly, the extensive knowledge and profound influence of entrepreneurial STEM education necessitates backing and help from various industries, particularly the commerce industry (38.7%, 12). Here, business mentors [E4, E8], business consultants [E4, E8], and entrepreneurs [E1, E4, E8, E10] contribute by offering guidance and motivation to trainees and providing evaluative feedback. Gradually incorporating aspects of entrepreneurship necessitates trainees to contemplate steps for commercialisation, including market and competitor analysis, in-depth user interviews, and more [E14, E18, E19, E23].

Research Impact

Table 5 shows the impact of entrepreneurial STEM education across the 31 articles selected for this study. This part firstly outlines the benefits of the integration of the two and categorizes them into individual level and team level. Subsequently, in order to clarify the benefits of the research to the trainees, we utilize the ASK model proposed by Benjamin Bloom, a renowned modern American psychologist and educator, to categorize the benefits of the research to the trainees. The individual level is classified by the ASK model, comprising Attitude, Skill, and Knowledge.

At the individual level, the 31 articles covered the most benefits in terms of skill improvement (87.1%, 27), succeeded by positive shifts in attitudes and emotions (45.2%, 14), and the least concerning knowledge acquisition (12.9%, 4). Notably, as most articles focus on individual-level improvement, the aggregate count of articles at the individual level exceeds 31.

The enhancement in abilities was classified into three categories: entrepreneurial, cognitive, problem-solving, and creative and innovative skills.

It is crucial to note that entrepreneurial skills mainly refer to the enhancement or acquisition of entrepreneurial skills by the trainees, including cost calculation, business plan formulation, and the confident and professional introduction of their engineering designs to the market [E5]. Thinking skills were mentioned in all nine articles but with different break-

Table 5 List of research benefits

	Category	Research impact
Individual level (45)	Attitude (45.2%, 14)	Motivation for academic learning [E4] Entrepreneurial mindset [E2, E6, E10, E15, E16, E25] Attitudes towards STEM fields [E12] Career aspirations [E12] Self-awareness [E15] Self-efficacy [E7, E16, E21, E22]
	Skill (87.1%, 27)	Entrepreneurial skills [E4, E5, E8, E12, E14, E15, E17, E19, E22, E28] Thinking skills [E4, E6, E7, E13, E20, E22, E24, E27] Problem-solving skills [E8, E13, E17, E20] Creativity and innovation skills [E3, E10, E13, E20, E21]
	Knowledge (12.9%, 4)	Knowledge of STEM [E5] Knowledge of entrepreneurship [E1, E3, E10]
Team level (16)	Group identity [E11] Ability to collaboration [E3, E7, E8, E13, E14, E18, E20, E21] Communication literacy [E3, E4, E8, E10, E11, E13, E20]	

downs in different articles, e.g. critical thinking [E7, E13, E20, E22], fostering entrepreneurial scientific thinking [E24], creative entrepreneurial thinking [E4, E27], interdisciplinary thinking [E7], and computational thinking [E6]. Positive shifts in emotional perspectives were classified such as motivation for academic learning, entrepreneurial mindset, attitudes toward STEM fields, career aspirations, self-awareness, and self-efficacy. Among these, six articles predominantly discuss entrepreneurial mindset, such as entrepreneurial traits (persistence, discipline, and creativity) [E2, E10], entrepreneurial intent [E6, E16], entrepreneurial readiness [E15], and entrepreneurial thinking [E25]. The knowledge growth is categorized into two types: knowledge of STEM and knowledge of entrepreneurship. The first primarily requires proficiency in STEM fields, whereas the second encompasses the understanding of some essential elements, procedural steps, and more for entrepreneurial success, such as understanding business and marketing strategy [E1, E10], familiarity with specific terms and methods [E3], an awareness of entrepreneurship's worth [E4], an awareness of business value [E5], and the importance of performing market evaluations [E3].

Viewed from a team standpoint, the primary aim of Entrepreneurial STEM education is to enhance the ability to collaborate [E3, E7, E13, E8, E14, E18, E20, E21] and improve communication literacy [E3, E4, E11, E13, E8, E10, E20]. Whereas some scholars have proposed its potential to foster a sense of group identity [E11].

The Types of Entrepreneurial STEM Education

Based on the extent of integration of entrepreneurial education into STEM education, the 31 articles are categorized into three types: the entrepreneurial element-embedded design, the whole-process integration, and the entrepreneurial project-driven design. Table 6 displays the articles along with their respective counts, categorized into three distinct types. Altogether, Type I comprises 10 articles, Type II has 9, and Type III includes 12 articles.

Type I which is named as the entrepreneurial element-embedded design, refers to the inclusion of entrepreneurship elements in STEM courses or projects in an element-embedded manner. There are two scenarios, the first one is to improve the entrepreneurship-related competencies of the trainees in everyday STEM education. As an illustration, in E2, scholars employed chemistry project-based learning with an Integrated Ethnoscience Approach in STEM (Ethno-STEM) to improve students' conservation and entrepreneurial qualities. The second is the inclusion of an entrepreneurial education phase in STEM education, yet the overall design of the process tends to favor STEM methodologies. As an illustration, during E17, E20, E21, and E26, the prototype phase is incorporated, and in E21, the concluding "launch" session, the educator motivates students to share their design process and products, contemplating manufacturing and potential markets.

Table 6 List of types of entrepreneurial STEM education

NO.	Pattern	References
Type I ($n=10$)	The entrepreneurial element-embedded design	[E2, E11, E13, E17, E20, E21, E24, E26, E28, E29]
Type II ($n=9$)	The whole-process integration	[E4, E5, E6, E7, E12, E14, E25, E27, E31]
Type III ($n=12$)	The entrepreneurial project-driven design	[E1, E3, E8, E9, E10, E15, E16, E18, E19, E22, E23, E30]

Type II which is named the whole-process integration, denotes the integration of entrepreneurial activities across a course or project, with scholars innovating and exploring novel educational methodologies in STEM education. Additional business stages such as Opportunity and resource analysis, Market research, Iterating, and Pitching are incorporated. This holistic method enables trainees to acquire subject expertise and collaborative abilities in the initial program, while also improving fundamental soft skills like interdisciplinary learning and critical thinking.

With the increasing integration of entrepreneurial education into STEM fields, it progressively manifests as the Type III which is named as the entrepreneurial project-driven design. The third type is mainly carried out through three forms of implementation: school curriculum, extracurricular activities, and educator training programmes. Comprising six articles, the school curriculum system encompasses STEM MBA, Entrepreneurial Master's Degree Training Direction, STEM Doctorate in Business Management, Strategic Management, Entrepreneurship Course (ENTR330), and Innovative Society Course (R2I2S) curriculum system [E1, E3, E10, E15, E16, E19], which is an entrepreneurial education tailored for individuals versed in STEM education with orientation being multi-course study. The Extracurricular Activities Programme consists of three articles [E8, E18, E22], which are implemented in the form of STEM-oriented entrepreneurship competitions, entrepreneurial projects, and summer programmes, specifically the YES Global Entrepreneurship Competition [E8], the Vigilante Innovation (VIX) project [E19] and the Poder programme [E22]. Comprising three articles [E9, E23, E30], the educator training programme focuses on cultivating innovative skills and teaching methods for Head Start and K-12 STEM educators.

Taken together, the Type III differs significantly from the Type I and Type II. The implementation cycle of the project, as observed through horizontal comparison, indicates that the Type III projects typically extend over several months or school years, necessitating entrepreneurship project interventions. It is evident in the overarching design emphasis, the Type III with entrepreneurship education as the core content, enabling participants in the whole project or curriculum to acquire specific entrepreneurial knowledge and skills, leading to a more thorough process of entrepreneurship and product creation. The extent of entrepreneurship integration into STEM education in these three types has progressively intensified (see Fig. 4).

To gain a deeper understanding of the patterns for each type of integrating entrepreneurial education into STEM education, an in-depth content analysis of these articles was conducted. We extracted the processes and elements of each article and summarised them to identify both similarities and differences among them. Subsequently, we graphed these results into charts that were unique to each type. These charts were able to show the characteristics of each type from a broader viewpoint, providing some valuable references and implications for future studies. By conducting these analyses, we gain a deeper insight into the commonalities and differences among various types, aiding in our comprehensive research and deeper investigation into related areas.

The Patterns for Each Type of Entrepreneurial STEM Education

Following an in-depth analysis and overview of each type, we intend to present the pattern of each article through flowcharts and explain the corresponding model of each type.

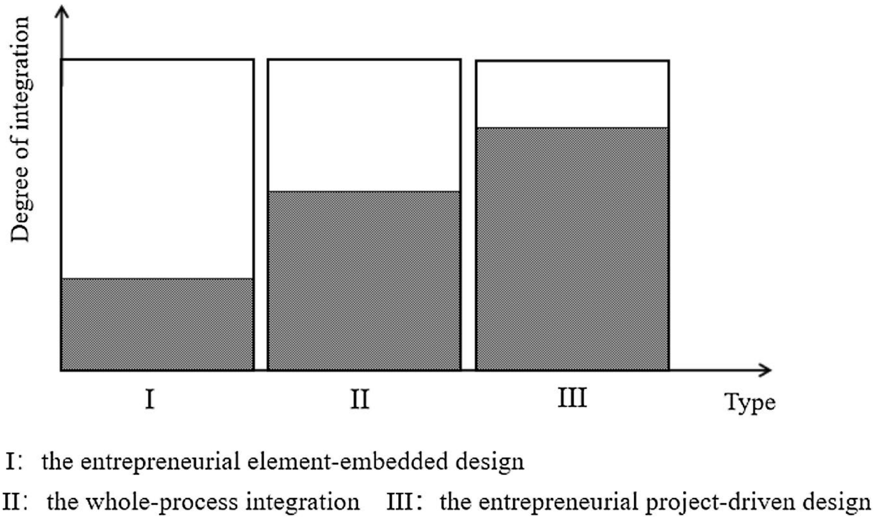

Fig. 4 The types of entrepreneurial STEM education

The Entrepreneurial Element-Embedded Design

As seen in Fig. 5, at the shallowest level of integration, the Model for Type I, entrepreneurship is merely embedded as a component of the curriculum's design, with STEM education continuing to predominate in the entire process.

The first step is to Identify and define problems. A majority of STEM courses begin by presenting challenges. To enhance the cognitive abilities of the trainees, the instructor will introduce various challenges and allow the trainees to methodically pinpoint and articulate these issues during a collaborative dialogue. In E2, the instructor presents the scientific idea of extracting essential oil and organizes a question-and-answer session to encourage students to think and pinpoint the issue. However, some scholars opt to immerse trainees in an authentic, naturalistic setting, enabling them to generate concepts via deliberate observation to discover uniqueness or strengths. In E24, students were instructed to examine images of contemporary product designs to collect data on construction materials, design, and product features for problem identification.

The second step is Research the need or problem. In this step, we need to expand on our research problem, such as considering the internal causes of the problem, the external causes, the impacts, the existing solutions, and so on. Naturally, in any problem, there is a subject, and we may have to understand the potential users and identify their actual needs. For example, a pacifier designed for better weaning and a toothbrush holder that would prevent buildup in the bottom of a cup, both of which appeared in the In Venture Challenge [E21], are good examples of research projects. Both examples illustrate well the necessity of the research question as well as the need for its subject matter.

Steps three, four, and five are a logical consistent process. After understanding the problem thoroughly, we will start to develop possible solutions, and after we have some solutions, we need to test and evaluate them to verify the validity and reliability of the solutions,

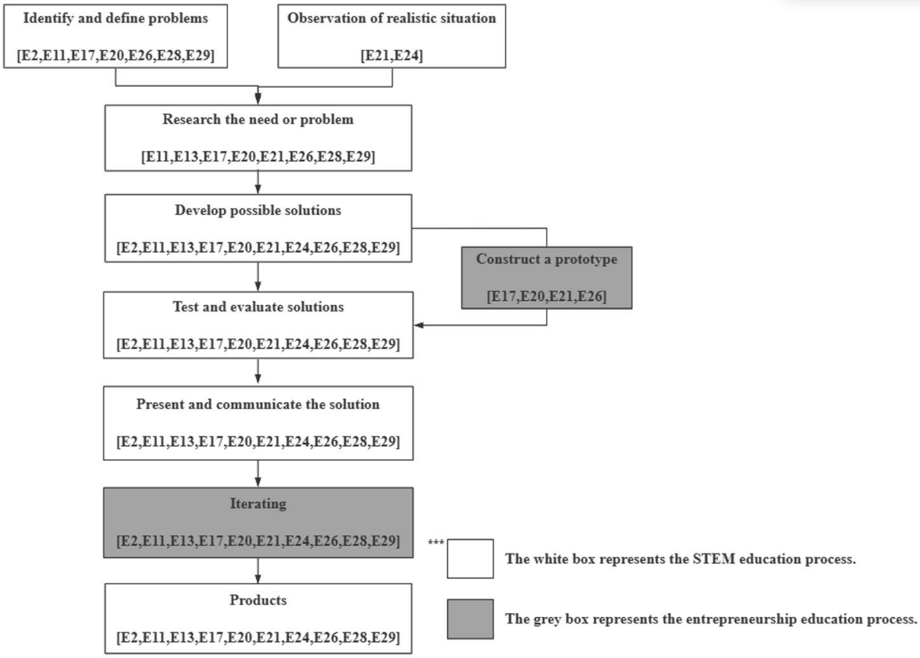

Fig. 5 The flow chart of the entrepreneurial element-embedded design (Type I)

and it is also necessary to present and communicate the solution with other groups to gather a broader range of viewpoints and concepts. It is also very important to present and communicate the solution with other groups to garner more opinions and ideas. In E26, after completing the background research, students actively brainstormed in their groups, coming up with and documenting different suggestions for a successful brand launch, including the idea of developing branded content. This was followed up with tests, examinations, and other groups demonstrating the best current methods of branding. The educator also sought proof of their rationale for the proposed methods and explained why they rejected the other methods. The authors of the four articles E17, E20, E21, and E26, on the other hand, proposed the business term "prototype" between the third and fourth steps, which usually refers to a preliminary model used for assessing, testing, and enhancing the feasibility of a design or concept. A prototype can be an initial realisation of a product, system, device, software, or other innovation that is intended to validate a design idea, identify possible issues and make improvements.

The sixth step (Iterating) involves an ongoing cycle of enhancement, where the team frequently iterates to improve the product's functionality, performance, and user experience. Each cycle contributes new elements or enhances current ones until the product's criteria are satisfied to achieve the ultimate outcomes.

The Whole-Process Integration

As depicted in Fig. 6, the whole-process integration of entrepreneurship into STEM education is more profound, with the project's overarching methodology centered around Type I,

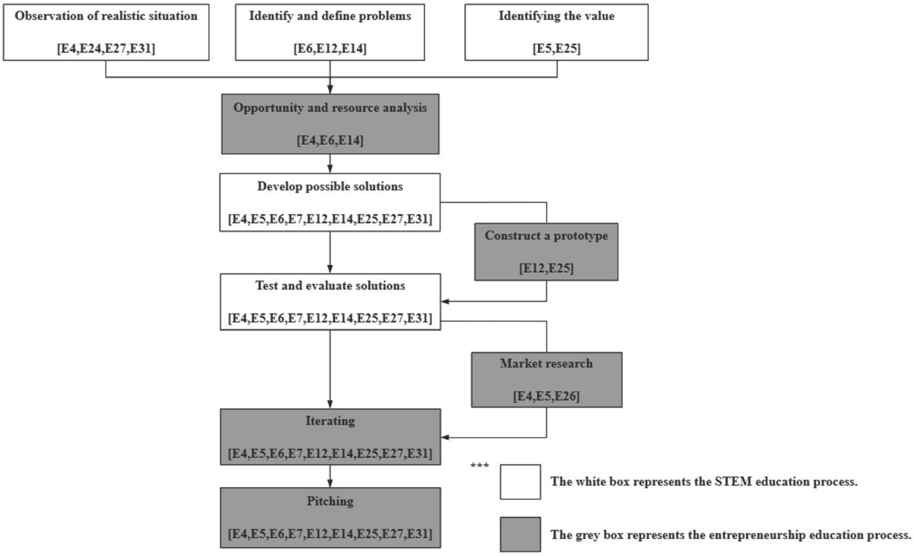

Fig. 6 The flow chart of the whole-process integration (Type II)

yet it has been amalgamated and restructured to suit the diverse educational requirements of entrepreneurship.

Diverging from Type I, the project's initial phase involves Identifying the value, necessitating contemplation on the significance of our selected issue for the individual, society, or the world. The purpose of the "blind person's currency" mentioned in E5 is to assist blind individuals in gauging the extent of their change, thereby preventing any deceitful actions.

The second step is Opportunity and resource analysis, entailing the examination of potential business or project opportunities and the necessary resources to capitalize on them. The significance of this procedure lies in its role in guiding strategic planning and decision-making, as it assists teams in pinpointing and ranking the most potential opportunities and evaluating their capacity to seize them. The process encompasses finalizing financial strategies, determining economic indicators, scrutinizing markets and rivals, and carrying out in-depth interviews with prospective buyers [E4, E6, E14].

Steps three, four, and five bear resemblance to Type I. Suitable solutions are crafted, subsequently trialed, and assessed, yet their integration into the market necessitates Market research. Market research refers to the process of systematically collecting, analysing, and interpreting information about the market, customers and the competitive environment. This process is designed to assist companies in grasping market demands, patterns, and prospects, thereby enhancing their market tactics and strategic business choices. As an illustration, in E5, the focus will be on crafting specific customers chosen to effectively differentiate their products and satisfy the demands of the intended market.

Iteration in this context mirrors that in Type I, aiming to ensure the product or solution's thoroughness and to continuously meet the customer's requirements. The concluding phase of the pitching process involves not only presenting and distributing the ultimate startup product but also initiating its entry into the market. This typically involves the display of a product, service, project, or concept to prospective investors, partners, or clients to

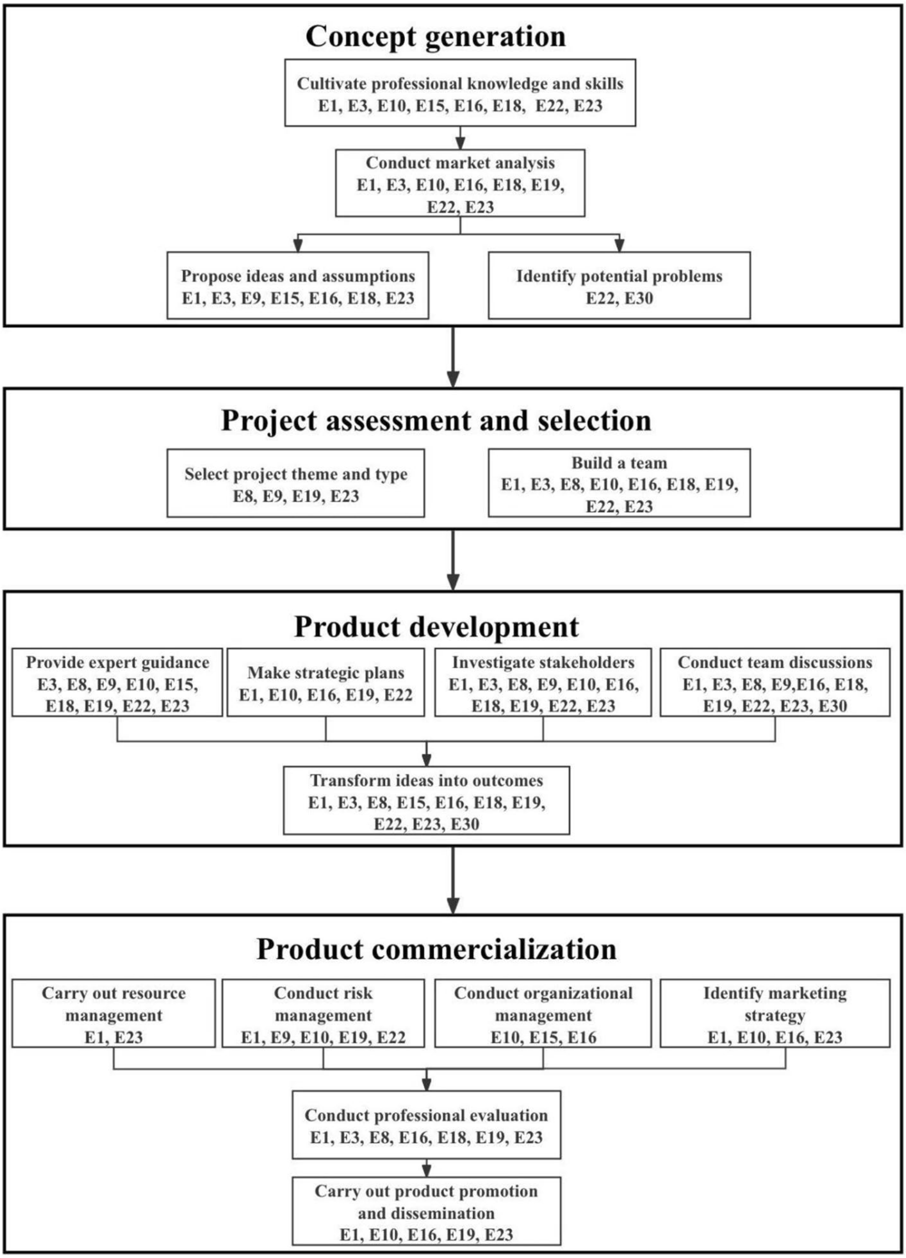

Fig. 7 The flow chart of the entrepreneurial project-driven design (Type III)

secure backing, cooperation, or revenue. Typically delivered during a conference, lecture, or business event, this presentation aims to spark interest and inspire subsequent actions like investing, partnering, or purchasing. Current research frequently employs entrepreneurs, business advisors, STEM educators, and various specialists as review groups to assess the product's market readiness.

The Entrepreneurial Project-Driven Design

An examination of the articles reveals that, in contrast to the first and second types with their distinct and uniform implementation phases, numerous researchers offer a broader macroscopic view of the third type's overall structure. The majority of the articles fail to provide a detailed implementation strategy or steps, instead concentrating on enumerating the elements incorporated in the projects. Furthermore, the third type's projects concentrate on fostering entrepreneurship education, aligning more closely with management disciplines, primarily through curriculum systems, extracurriculars, and teacher training. This is achieved by acquiring professional knowledge and skills, market analysis, management, and various other areas. The goal is to progressively realize the transformation of the business concept, targeting students with a STEM background, and incorporating STEM aspects into the project's design, ensuring a high degree of integration between STEM and entrepreneurship education.

Reflecting on the varied structures and disjointed elements of the third type, we utilized the four-stage product development model (Tidd & Bessant, 2020) to elucidate the execution procedure and components of these projects, amalgamating the twelve articles related to the third category of crucial aspects of the entrepreneurial initiatives crafted by the researchers, as shown Fig. 7. The primary objectives of the third type focus on commercializing, achieving, and producing the issues, concepts, and theories introduced, with many projects aiding participants in navigating the entire product development journey through multi-curricular links, long-cycle activities, and continuous training. This research utilizes a streamlined four-phase new product development model (Tidd & Bessant, 2020) to elucidate the procedural aspects of Type III projects. This refined model, after evaluating various model stages, encompasses four phases: concept generation, project assessment and selection, product development, and product commercialisation.

The initial Stage, known as the Concept generation, concentrates on generating fresh ideas, challenges, and hypotheses. To successfully generate concepts, the majority of those involved in the project will initially engage in cultivating professional knowledge and skills, encompassing theoretical learning in areas like entrepreneurship and market theory [E10, E15, E16], acquisition of relevant technology [E1, E22, E23], and training in skills like translation and communication [E3, E16, E18], aiding in the seamless execution of future projects. Conducting market analysis serves as a method for participants to comprehend the market and gather data, and plays a crucial role in the development of products. Participants in Type III projects engage in market analysis, delving into the market context, scrutinizing market information, and pinpointing market prospects to comprehend the placement of the upcoming product, aid in investigating possible market opportunities, and develop various ideas, inquiries, and hypotheses [E1, E3, E10, E16, E18, E19, E22, E23]. With ample knowledge, skill development, and market insight, participants in the project have investigated possible issues, developed market theories, and elucidated novel business concepts and initial product ideas in their deliberations and dialogues [E1, E3, E9, E15, E16, E18, E22, E23, E30], aiming for conceptual development of products.

Stage two encompasses the evaluation and choice of the Project, entailing the selection of projects that fulfill the conditions. During this stage, the majority of those involved in the project engage in collaborative efforts [E1, E3, E8, E10, E16, E18, E19, E22, E23] to choose and assess the selected project and theme. They form either a multidisciplinary group or a collective of individuals with similar interests who have developed throughout the project and theme selection process, showcasing the blend of STEM and entrepreneurial aspects. reflecting the fusion of STEM and entrepreneurial elements.

Stage three involves the Product development phase, where participants engage in various developmental stages to transform a chosen idea into a tangible product. the common emphasis of these projects is that the selected initial concept project will be converted into a final product in a team format according to a developed strategic plan, under the guidance of experts and based on feedback from stakeholder research. Through this process, the participants outlined their strategic plans by creating a business plan, drafting a work plan, and organizing a development program [E1, E10, E16, E19, E22]. The range of expert advice is diverse, encompassing workshops led by business consultants, patent specialists, and external expert investors, mentorship schemes, and offering sample guidance [E3, E8, E9, E10, E15, E18, E19, E22, E23]. The concept of 'investigate stakeholders' is deeply ingrained, fostering relationships among various stakeholders via customer interactions, grasping shareholder viewpoints, and managing strategic partners, laying a solid groundwork for future product launches [E1, E3, E8, E9, E10, E16, E18, E19, E22, E23]. Consistent with earlier stages, the actualization of the product occurred via collaborative dialogues [E1, E3, E8, E9, E16, E18, E19, E22, E23, E30], in which attendees identified and addressed issues in the product's creation via workshops and collective discussions [E1, E3, E8, E9, E10, E16, E18, E19, E22, E23]. There are multiple methods to showcase the product. The product's display is varied, converting the initial hypotheses and inquiries from the first stage into tangible solutions through creative objects, proposal reports, and business model canvases [E1, E3, E8, E15, E16, E18, E19, E22, E23, E30].

Stage four encompasses the commercialization of the product, entailing its testing, launching, and marketing. During this stage, the project participants' pre-existing knowledge is leveraged to introduce the company's novel product to the market. This is done by utilizing their understanding of resources, risk, and organizational management, implementing the marketing strategies they've acquired, gathering insights from expert reviews, and employing diverse methods to market and spread the product for commercial success. In this stage, managing resources aids in assessing cost assets and enhancing key resource utilization [E1, E23], while risk management assists in risk perception and market engagement through a less risky business approach [E1, E9, E10, E19, E22]. Additionally, organizational management assists in comprehending risks and encourages active market involvement using a less risky business model [E1, E9, E10, E19, E22]. The practice of organizational management opens avenues for managing growth and ensuring product sustainability [E10, E15, E16]. Marketing plays a crucial role in the commercialization of products [E1, E10, E16, E23]. The process of professional assessment serves as the entry point to the official commercialization of products, offering expert counsel and perspectives derived from a professional evaluation strategy, decisions of expert panels, and input from outside specialists [E1, E3, E8, E16, E18, E19, E23]. Across various initiatives, participants marketed the tangible product via multiple media outlets, including video creation, canvas exhibitions, and website creation [E1, E10, E16, E19, E23] to garner increased interest.

Utilizing a streamlined four-phase model for developing new products, the contents of the 12 articles in Type III were systematically arranged to align, culminating in the creation of a pattern diagram for Type III projects. Over time, as these stages progress, participants engage in STEM entrepreneurship education led by entrepreneurship education, acquire relevant knowledge and skills, and achieve the dual objectives of nurturing both STEM and entrepreneurship education. At every phase, the focal points of the four stages vary, aligning with diverse components. Utilizing this method, the various aspects of entrepreneurship STEM education, initially dispersed across 12 articles, were amalgamated, allowing us to distinctly delineate the identical function of these components. For instance, an expert's role extends beyond merely advising on product development to playing a crucial role in the commercialization of the project product. In summary, this model element map integrates the commonalities and core elements of the Type III projects examined in this research, structuring them into a coherent sequence for application.

Comparison and Summary of the Patterns for Each Type

The systematic review article conducted a comprehensive analysis of incorporating entrepreneurial education into STEM education, identifying three distinct integration patterns: entrepreneurial element-embedded design, whole-process integration, and entrepreneurial project-driven design.

The entrepreneurial element-embedded design (Type I) involves incorporating elements of entrepreneurship within STEM courses or projects as an additional component, rather than the main focus. This approach typically aims to enhance students' entrepreneurship-related competencies within the context of regular STEM education or includes a phase of entrepreneurial education within a predominantly STEM-focused methodology.

Whole-process integration (Type II), on the other hand, represents a deeper level of integration where entrepreneurial activities are woven throughout the entire course or project. This holistic method allows students to gain subject expertise and collaborative abilities while also enhancing essential soft skills like interdisciplinary learning and critical thinking. It begins with identifying the value of the issue and includes opportunity and resource analysis, market research, and pitching as part of the process.

Lastly, the entrepreneurial project-driven design (Type III) is the most intensive level of integration, where the entire project or curriculum centers around entrepreneurship education, with a strong emphasis on the commercialization process. This type is implemented through school curricula, extracurricular activities, and educator training programs, characterized by a long-term, in-depth process that leads to a thorough understanding of entrepreneurship and product creation.

In summary, while Type I adds entrepreneurial elements as an additional component to STEM education, Type II integrates entrepreneurship throughout the STEM educational process, and Type III focuses intensely on entrepreneurship education, aligning more closely with management disciplines through curriculum systems, extracurriculars, and teacher training. Each type reflects an increasing level of integration of entrepreneurial education into STEM, offering different pathways to cultivate entrepreneurial thinking and skills within the STEM Education.

Discussion

To address the research questions posed at the outset, we should revisit and provide more definitive answers. In response to RQ1, the descriptive analysis has characterized current studies on integrating entrepreneurial education into STEM education. For RQ2, our in-depth analysis identified three distinct types of integration: entrepreneurial element-embedded design, whole-process integration, and entrepreneurial project-driven design. Each type represents a different level of integration, from a supplementary component in Type I to a comprehensive and core element in Type III. Regarding RQ3, the flowcharts provided for each type offer a practical template for understanding the integration patterns. Type I shows entrepreneurship as an additional component to the STEM curriculum, Type II illustrates a more integrated approach throughout the educational process, and Type III displays a project-driven, in-depth integration of entrepreneurship.

Integration remains a key term in this research. The purpose of integration is to enhance all aspects, which in turn propels the integration process forward. As we have concluded, integrating entrepreneurial education into STEM education has both individual and team-level implications. This empowers individuals with a varied array of skills, encompassing both technical abilities and entrepreneurial mindset and competencies. This equips them to navigate the complexities of modern workplaces and fosters a proactive approach towards problem-solving and innovation. Alongside improving collaborative and communicative abilities, these two levels are interconnected both within and outside the organization, guaranteeing that STEM education stays pertinent to industrial demands by providing students with the necessary competencies and attitudes to excel in dynamic and evolving fields. his approach narrows the divide between academic and industrial sectors, easing the transition process for graduates into the job market (Ferreira et al., 2021). At the same time, we have found that the integration of the two brings with it some unavoidable challenges. One of the primary challenges is the potential for curriculum overload. STEM subjects are already dense with content, and adding entrepreneurial concepts can stretch the curriculum thin. Educators may struggle to find the right balance between covering essential STEM material and integrating entrepreneurial principles without overwhelming students.Ensuring that entrepreneurial education is not just an add-on but is cohesively integrated with STEM subjects is a challenge. It requires a thoughtful approach to curriculum design that allows for the natural intertwining of technical skills with entrepreneurial thinking.

The many advantages of integrating entrepreneurial education into STEM education have recently highlighted the fusion of STEM education and entrepreneurship as a prominent research subject. However, it has also been noted that entrepreneurial elements are frequently absent in STEM courses at colleges and universities (Camesano et al., 2016). Eliminating entrepreneurial elements from STEM curricula could result in diminished enthusiasm and learning inclination among STEM students, coupled with a deficiency in their critical thinking and problem-solving abilities when faced with novel scenarios (Sheffield et al., 2018). Furthermore, comprehending STEM education, which paves the way for discoveries, inventions, or products, may diminish in significance without a fundamental grasp of the market dynamics. The integration of STEM and entrepreneurship education can aid in addressing these issues. In this study, we have classified these articles into three types based on integration levels, and the evolving patterns of each type indicate its progression. Teaching becomes more challenging as the demand for students to possess knowledge and skills in entrepreneurship escalates. As for the overall mode of delivery, it ranges from the traditional classroom to hands-on practice in projects to taking place in vibrant entrepreneurial ecosystems that include universities, research institutions, startups, incubators, accelerators, and industry partners (Huang et al., 2018). These ecosystems foster a culture of entrepreneurship and innovation by providing students with resources, networks, funding support, and mentoring.

Overall, entrepreneurial STEM education is evolving to meet the needs of a dynamic and connected world, providing students with the knowledge, skills, and mindset needed to succeed as innovators, entrepreneurs, and leaders in the 21st century. The three types and patterns proposed in this study will aid future scholars in enhancing the design of entrepreneurial STEM courses and deepening their comprehension of the interplay between entrepreneurial and STEM education.

Conclusions

In conducting this systematic analysis, we utilized PRISMA methods and identified 31 eligible papers on the topic in this study. In addressing the first research question, a descriptive analysis has been conducted to provide a comprehensive description of the publication year, the first author's nation, research methods, participants, and impact. In addressing the second research question, we undertook an in-depth analysis of the selected literature. The analysis guided us to categorize the articles into three types, each reflecting different levels of integration of entrepreneurial education into STEM education: the entrepreneurial element-embedded design, the whole-process integration, and the entrepreneurial project-driven design. Additionally, addressing the third research question, this research encapsulates the flowcharts for various types, aiming to furnish future scholars with a practical template reference.

The insights gained from our research have enriched our grasp of entrepreneurial STEM education, and it is our aspiration that these findings will aid in advancing curriculum design and content analysis in this field. Our aspiration is that these recent findings will open up fresh research avenues and offer valuable advice and perspectives for educators, learners, entrepreneurs, and other stakeholders in entrepreneurial STEM education. For educators, the study provides a comprehensive understanding of effectively integrating entrepreneurial education into STEM curricula. It offers insights into various models and strategies, enabling them to enhance their teaching methods and curricular designs to better prepare students for the challenges of the 21st century. For learners, the research highlights the benefits of an integrated entrepreneurial STEM education, such as developing critical thinking, problem-solving, and creativity. It emphasizes the importance of acquiring both technical skills and an entrepreneurial mindset necessary for innovation and adaptability in various professional contexts. For entrepreneurs, the study offers an evidence-based perspective on the value of entrepreneurial education within STEM fields. It can inspire collaboration with educational institutions to develop programs that nurture future innovators and business leaders who can drive economic growth and job creation. For the research community, the study provides a systematic review that consolidates existing knowledge and identifies gaps for future investigation, opening avenues for new research projects to further explore the nuances of integrating entrepreneurship into STEM education. Generally speaking, our conviction is that the incorporation of entrepreneurial education into STEM fields can persistently be explored for enhanced growth and future advancement opportunities.

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Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request. The data sets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Conflict of Interest The authors declare that they have no conflict of interest.

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