



Theory article

Evaluation of entrepreneurship failure education in higher education from the perspective of the CIPP model and AHP-FCE methods

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Abstract: Entrepreneurial failure education aims to equip entrepreneurs with the knowledge and skills necessary to navigate entrepreneurial setbacks and enhance their ability to manage failure effectively. The evaluation system of EFE is a crucial tool to estimate the development of entrepreneurial failure education (EFE) in universities and colleges, which ensures the high-quality development of EFE in universities and colleges. Based on the concept of EFE in universities and colleges, we built an evaluation index system of entrepreneurship education in universities and colleges in the context of the CIPP model. In addition, an evaluation model of EFE in colleges and universities was constructed by employing the fuzzy comprehensive evaluation (FCE) and analytic hierarchy process (AHP) technique. Moreover, the sample data from five universities in Hebei, Shanxi, and Jiangsu were chosen for evaluation research. The findings indicated that the EFE in higher education institutes was typically in an “average” state; the status of context, input, process, and product were relatively “strong”, “very weak”, “average”, and “relatively weak”. Thus, universities and colleges must strengthen the management ability of entrepreneurial failure, support the development of teachers, enhance the cultivation of entrepreneurial practice ability, construct the curriculum system of EFE in universities and colleges, and execute the implementation of entrepreneurial policies. This study provides an effective evaluation tool for EFE in colleges and universities and an essential reference for the quality of EFE in colleges and universities.

Keywords: entrepreneurial failure education (EFE); FCE method; CIPP model; AHP technique; education evaluation

1. Introduction

Owing to the promulgation of a series of entrepreneurial innovation policies, such as “Opinions on Several Policies and Measures to Vigorously Promote Mass Entrepreneurship and Innovation”, “Implementation Opinions on Deepening the Reform of Innovation and Entrepreneurship Education in Colleges and Universities”, and “Guiding Opinions on Further Supporting College Students’ Innovation and Entrepreneurship”, universities and colleges in China actively respond to the call of national entrepreneurship’s education reform, thereby, establishing entrepreneurship colleges and research institutes, revising the entrepreneurship education system, creating the entrepreneurship platforms, and improving the entrepreneurship curriculum system. Consequently, college students are encouraged to participate in national, provincial, university, and other multi-level entrepreneurial competitions such as “Internet Plus”, “Challenge Cup”, “Creating Youth”, and “Double Innovation Training Program”. Moreover, college students’ entrepreneurship is not only in full swing but also in the ascendant. However, college students in China exhibit weak management ability for entrepreneurial failure, an imperfect curriculum system for entrepreneurial failure, a shortage of EFE teachers, poor ability of entrepreneurial practice, concept lagging behind EFE, and insufficient execution of entrepreneurial failure support policies, as compared to the developed economies [39,44]. Consistent with the 2022 Employment Report of College Students in China, more than half of the undergraduates who preferred to commence business after graduation in 2018 decided to quit their businesses within three years, and the graduates’ proportion (41.5%) that opted not to quit, is further reduced than the same period in 2017 (43.4%); additionally, 60% of the vocational institute’s graduates who initiated their businesses, chose to quit within three years, whereas the graduate’s proportion (39.5%) that decided to continue their businesses is further lowered as compared to the same period in 2017 (41.0%). On one hand, entrepreneurial failure can be attributed to factors such as entrepreneurs’ overconfidence [6], insufficient entrepreneurial resources, absence of a supportive system [11], and limited entrepreneurial experience [26]. On the other hand, the aforementioned statistical data not only indicate that the failure rate of college students’ entrepreneurship is high in China but also confirm the result of the separation of entrepreneurship failure education (EFE) and entrepreneurship practice [44,41,49], thus putting forward higher needs for entrepreneurship education in universities and colleges. Consequently, there is a dire need to add the content of education failure to entrepreneurship education, emphasize the significance of EFE, and realize the integrated development of “entrepreneurship education” and “failure education”.

The EFE caused by entrepreneurial failure has become an essential academic concern worldwide. Researchers have focused on the cognition of EFE, the curriculum construction of EFE, and the significance of EFE. For instance, Zhang [48] reported in Higher Education in China that entrepreneurship education must be primarily based on “failure education” while there is also a need to urgently change the notion of entrepreneurship education that only anchors “great success”. Further, it is essential to teach college students to effectively recognize and manage potential failure to move from entrepreneurial failure to entrepreneurial success. In the course construction of EFE, Yu et al. [44], Luo [21], Xu [38], Zhang [49], Zhou et al. [55], and Zhang and Xu [52] conducted exploratory analysis on the issues related to entrepreneurship education, such as “entrepreneurial success orientation”, curriculum setting of entrepreneurial failure, the relationship between entrepreneurial education and entrepreneurial failure learning, and the educational strategies of college students after entrepreneurial failure. They think that the role of entrepreneurial education in colleges and universities

cannot be ignored, and the curriculum system of EFE needs to be constructed urgently. In terms of the significance of EFE, Guo [10], Xu and Zhang [39] pointed out that as an essential part of entrepreneurship education in colleges and universities, EFE is not only of great significance in improving college students' cognition of entrepreneurship failure, enhance their learning ability of entrepreneurship failure, their willingness to start a new business and cultivate their management ability of entrepreneurship failure, but also plays a supporting role in building a complete entrepreneurship education system for college students, solving the "three lows" problem of entrepreneurship and improving the quality of talent training.

In addition, owing to the deepening of the practice of "double innovation" in China, EFE in educational institutions shall become an integral part of the innovation and reform of entrepreneurship education. Moreover, EFE serves as a significant guarantee for the high-quality and sustainable development of entrepreneurship education in China's educational institutions. Specifically, what is the quality of EFE in colleges and universities at present? What are the outstanding problems? How to really promote the high-quality development of entrepreneurship failure education in colleges and universities? To answer the above questions, it is urgent to build a scientific and effective evaluation framework for EFE in colleges and universities to objectively evaluate and rationally locate EFE in colleges and universities more accurately, and then explore relevant benefits and drawbacks, and put forward corresponding countermeasures and suggestions. Presently, the studies on the evaluation of entrepreneurship education in higher education institutes focus on choosing evaluation methods and building an evaluation index system [10,16,37,42], and achieved many theoretical results. Although, to the best knowledge of the authors, no research scholars at present have conducted an empirical analysis on the estimation of EFE in higher education institutions. The researchers not only lack sufficient attention to the EFE but also lack the systematic intellect to thoroughly evaluate the education of entrepreneurial failure.

The theme of this study has yet to be fully explored in previous studies and needs to be further supplemented and enriched. First, researchers mainly investigated the evaluation of entrepreneurship education in colleges and universities [10,16,37,42]. Under economic transformation and double innovation practice, EFE in colleges and universities has become essential. This means promoting the double innovation activities of college students and reforming entrepreneurial education. However, how to judge the quality and effect of entrepreneurship failure education in colleges and universities has not been given enough attention. Second, studies have applied the CIPP (Context, Input, Process, Product) model to classroom teaching evaluation [36], practical teaching evaluation [4], and teaching quality evaluation [15,35], but few studies have discussed the application of CIPP model in the evaluation of EFE. Third, the AHP-FCE method has been applied in dual-innovation education, postgraduate education, and classroom teaching, but it is rarely applied in entrepreneurship failure education. To sum up, this study mainly discusses the evaluation of EFE in colleges and universities, based on CIPP model, sample data of five universities in China and AHP-FCE method, providing scientific and practical evaluation tools for EFE in colleges and universities and providing decision-making references for developing EFE in colleges and universities.

The paper is organized in the following manner. In Section 1, we put forward the research questions and gives the structure of the paper. In Section 2, we provide a literature review and theoretical basis. We sort out the relevant literature on evaluating entrepreneurship education in colleges and universities and introduces the CIPP model, AHP method, and fuzzy comprehensive evaluation method. In Section 3, we construct the index system of entrepreneurship failure education

in colleges and universities based on the CIPP model, collects samples, and determines the weight by AHP. In Section 4, we include a fuzzy comprehensive evaluation and result analysis. In Section 5, we include research conclusions, suggestions, and limitations.

2. Literature review and theoretical foundation

2.1. The concept of EFE

The education of entrepreneurial failure can be traced back to scholarly research on entrepreneurial failure. For instance, Bruno et al. [1] termed the withdrawal of enterprises attributed to the transfer or termination of ownership as the concept of entrepreneurial failure. Similarly, Zacharakis et al. [45] described entrepreneurial failure as the closure of enterprises marked by collapse or bankruptcy. Conversely, certain researchers suggest that since entrepreneurs fail to achieve their goals and expectations, they are forced to terminate their operations or quit their businesses as entrepreneurial failure [43]. Most often, individuals lack proper knowledge of entrepreneurial failure due to the influence of “failure prejudice”; thereby leading to a high failure rate. Parallel to this, McGrath [22] called for the education of entrepreneurial failure and concluded that the learning, cognition, and repair of entrepreneurial failure are significant to entrepreneurial failure management. Zhang [48] proposed that entrepreneurship education should not forget the failure cases. Zhang [49] further pointed out that failure education should not be ignored in entrepreneurship education. Xu and Zhang [39] discussed the path and guarantee of entrepreneurship failure education. Undeniably, scholars at home and abroad have made meaningful discussions on the EFE, but the concept of EFE has not been clearly defined. Drawing on the principle of pedagogy and theory of entrepreneurial failure, we perceive EFE as a theoretical system of creating, sharing, learning, and applying entrepreneurial failure knowledge based on the entrepreneurial failure experience, thus conveying the scientific- and practical knowledge and coping strategies of entrepreneurial failure to entrepreneurs, guiding graduates to rationally commence their businesses, establishing entrepreneurial confidence, enhancing their crisis awareness and anti-frustration capacity, improving their entrepreneurial ability, dialectically learning from failed experiences, forming an appropriate concept of entrepreneurial failure, and developing a “rational attitude towards failure and cautious analysis”. Moreover, education on entrepreneurial failure includes the fundamental theory of entrepreneurial failure, failure attribution, failure learning, interpretation of classic failure cases, failure repair, and education of failure scenarios in simulation training and re-entrepreneurship. Studies demonstrate that the EFE is dominated by developing a positive entrepreneurial attitude of entrepreneurs, guiding them to strengthen their confidence, maintaining a rational attitude, studying the root causes of entrepreneurial failure, encountering potential failures with determination, and finally moving towards entrepreneurial success [30,39,44,46]. Therefore, failure education not only entails entrepreneurs with a “completely transformed” concept of the change, exploration spirit, psychological, and behavioral change but also inspires entrepreneurs to learn from failure [8], refine their entrepreneurial knowledge, identify the root causes of failure, accumulate valuable experiences, and develop skills to avoid repeating mistakes and rapidly recover from the haze of failure [41].

2.2. Evaluation of the EFE

The evaluation of EFE is highly scarce, whereas the related literature majorly focuses on the assessment of entrepreneurship education in higher education institutions. Moreover, the research analysis on the appraisal of entrepreneurship education can be traced back to the USA in the 1940s. Accordingly, Harvard Business School launched entrepreneurship education courses in 1947. After that, entrepreneurship education continued to develop in the US. Consequently, the evaluation system consisted of content standards, evaluation scales, and practice standards [19]. Although Businessweek in the United States began to make an annual assessment of entrepreneurship education in higher education institutes in the 1990s based on the rate of college students entrepreneurship, the number of entrepreneurship courses, and the quantity of financing needed to commence a business [13]. Wyckham [34] argued that entrepreneurship education lacked a unified evaluation standard in educational institutes. Afterward, Fayolle [5] innovated the appraisal technique for entrepreneurship education curriculum by adopting the theory of planned behavior. Moreover, domestic research on estimating entrepreneurship education in China began with Li's [18] implications on entrepreneurship education appraisal. After that, several research scholars have focused on the models, elements, subjects, and methods of entrepreneurship education. From the perspective of entrepreneurship education elements, Mei [23] classified the entrepreneurship education assessment in higher education institutes into policy and prevalent situation-, process-, and influence evaluation. Shu et al. [27] introduced an appraisal system of entrepreneurship education in universities and colleges, including entrepreneurship practice, entrepreneurship teaching, platform construction, entrepreneurship atmosphere, and training effect. In addition, Qiu [24] developed the evaluation index system of entrepreneurship education from the construction of teachers, entrepreneurship knowledge education, and the establishment of an entrepreneurship platform, the training of entrepreneurship ability, and the impact of entrepreneurship education. Besides, Guo [10] put forward a seven-dimensional evaluation system involving entrepreneurial ability, entrepreneurial theoretical knowledge, entrepreneurial activities, entrepreneurial practical ability, security support, social contribution, and organization and management. From the standpoint of entrepreneurship education, Kou and Chen [15] built an index system of entrepreneurship education in educational institutions in the context of students, universities, government, and colleges and universities. In terms of the entrepreneurship education model, Shen [25], Diao and Yu [4], Yang [40], and Zhang and Liu [51] developed the appraisal system of entrepreneurship education in higher vocational institutes from the perspective of the CIPP model. Further, researchers analyze the evaluation methods, focusing on the AHP, neural network, entropy, and FCE methods [15,31,32]. The proposed theories and methods of entrepreneurship education appraisal extend the theoretical ground and model for analyzing EFE assessment in educational institutes.

2.3. CIPP model

The evaluation model of CIPP put forward by Stufflebeam, an American educator, in the 1960s, is widely accepted and recognized internationally. The model includes four parts: Context evaluation, input evaluation, process evaluation, and product evaluation. Context evaluation mostly includes evaluating whether the policy environment, objectives, and schemes of the object are reasonable, clarifying the needs of the object to be evaluated and the opportunities to meet them [29], and judging

whether the object has the requirements and rationality for evaluation; input and evaluate the allocation and investment of main types of required resources; process evaluation includes all kinds of events and activities in the process of program implementation; the evaluation of results includes the evaluation of the results of program implementation.

The CIPP model has developed into a mature, scientific education and teaching evaluation system. The model is mostly used to echo the design of the evaluation scheme with the education plan, form a cycle of the selection of educational objectives, invest in educational resources, implement educational activities, evaluate educational effectiveness and each link, and constantly provide feedback and revisions between the front and back links to form a closed-loop system of educational control and evaluation [40]. It cannot only effectively evaluate the effects produced in the education process according to the needs of entrepreneurship education, thoroughly evaluate the scientificity and rationality of the objectives, but also double evaluate the achievements and process and make the evaluation to improve and optimize the quality of education and teaching based on the design idea of the whole process. As Stufflebeam [29] pointed out, “The most important purpose of the evaluation is not evaluation but improvement”. Therefore, the CIPP model represents an education appraisal model which comprehensively and comprehensively analyzes the whole scenario of EFE [50]. As a result, we intend to adopt the CIPP model to build the evaluation index system of EFE in higher education institutes.

2.4. The method of determining the index weight

The term ‘index weight’ denotes the quantitative value assigned to each index of a measured object within the entirety of the assessment, indicating its relative significance and proportion. At present, many methods to determine the weight have been put forward in the field of humanities and social sciences, such as the analytic hierarchy process, scoring method, priority diagram method, entropy reproduction method, Delphi method, factor analysis method, and CRITIC method [12,56]. As a decision analysis method combining qualitative and quantitative analysis, the analytic hierarchy process (AHP) was put forward by T. L. Satty in the 1970s, and it is defined as a simple and efficient index weight calculation method. This method decomposes the elements that need to be decided into three levels: Target, criterion, and scheme, and makes the final decision by fuzzifying the qualitative index information into simple and precise mathematical operation results [53]. Its basic steps include establishing a hierarchical structure model, constructing a contrast matrix, calculating the weight vector and making a consistency check, calculating the combined weight vector, and making a consistency check. Compared with other weight determination methods, this method is simple, scientific, and low-cost. On the one hand, this method quantifies and standardizes the decision-makers subjective judgment and thinking process so that thinking can be carried out in a specific order and rules. Furthermore, the uncertain factors are significantly reduced. On the other hand, this method keeps the consistency of the decision-makers thinking and decision-making process. It dramatically simplifies the system analysis and complex operation process, especially for decision-making problems involving complex systems [20]. Therefore, this method has strong practicability and effectiveness in dealing with complex problems and has been widely used in education and teaching, behavioral science, agriculture, talents, innovation, and other multidisciplinary fields.

2.5. Fuzzy comprehensive evaluation

The fuzzy comprehensive evaluation method was put forward in the 1960s, which is a comprehensive evaluation method based on fuzzy mathematics theory. This method can evaluate multi-attribute decision-making using mathematical theories and methods [53]. The basic idea of the fuzzy comprehensive evaluation method includes determining the weights of evaluation factors and indicators at the first level, using fuzzy sets to describe the fuzzy boundaries of each factor and indicator with membership degree, constructing a fuzzy judgment matrix, and finally determining the grade of the evaluation object through the multi-layer compound operation. The fuzzy comprehensive evaluation method has significant advantages in dealing with qualitative, uncertain, and imperfect information, which can compensate for the shortcomings of a single evaluation method [33]. The education of entrepreneurial failure is influenced by many factors, including background, input, process, and achievements, and it is difficult to describe it directly. It is feasible to evaluate the education of entrepreneurial failure by the fuzzy comprehensive evaluation method in this study.

2.6. The application of AHP-FCE

The AHP method not only explains the critical influence relationship between evaluation indexes with weights but also solves the problem that it is difficult to determine the weights of complex evaluation indexes in the FCE evaluation method. Furthermore, the fuzzy mathematical model can effectively solve many fuzzy and difficult-to-quantify problems in the evaluation index of innovation failure education quality. In addition, many teaching application examples in colleges and universities based on this method also provide evidence for the scientificity and effectiveness of this combined method. In other words, because of its theoretical basis and strong practicability, the AHP-FCE method has been widely applied in education in recent years. Chang and Shi [2] applied the analytic hierarchy process and fuzzy comprehensive evaluation method to evaluate the innovation and entrepreneurship education of design majors in colleges and universities, providing a theoretical basis for improving dual-innovation education. Zhang et al. [47] constructed the evaluation method system of postgraduate education quality based on AHP and fuzzy comprehensive evaluation. Jiang and Yu [14] adopted the AHP-FCE method to establish the evaluation method of classroom teaching quality in higher vocational colleges. AHP-FCE has been proven to be a scientific and feasible educational methodology [3,40]. Therefore, in this study, the combination of AHP and FCE is applied to the evaluation of EFE, which adapts to the characteristics of difficult quantification and complex objectives in the evaluation of EFE, and the results can provide scientific support for the construction of educational quality evaluation of entrepreneurial failure [15].

3. Study design

3.1. Development of an evaluation index system based on the CIPP model

In 1983, Stufflebeam primarily proposed the CIPP model as an educational appraisal model consisting of four dimensions: context, input, process, and product evaluation. Moreover, each part of the stated model represents a relatively independent system. The CIPP model evaluation is meant to ensure the realization of the goal and extend adequate information for educational decision-makers.

Therefore, “the most imperative reason behind the appraisal is not to prove, but to improve”, which holds that assessment is not a tool only to find faults or appraise performance but an effective “decision-oriented model” that is helpful to make the scheme more effective [35].

Table 1. Evaluation index system of EFE in colleges and universities.

Target layer	Criterion layer	Sub-criterion layer
Evaluation index system of EFE in colleges and universities	Context evaluation	Establishing the Management Department of EFE (C1)
		Fusion of entrepreneurship failure education and talent training system (C2)
		Universities have a strong educational concept of entrepreneurial failure (C3)
		Policy support for entrepreneurship (C4)
	Input evaluation	Entrepreneurship failure education is well funded (C5)
		Entrepreneurship failure education teachers are sufficient (C6)
		Entrepreneurship platform support (C7)
		Input in the theory and practice course of entrepreneurship failure education (C8)
	Process evaluation	The curriculum system of entrepreneurship failure education has been established (C9)
		Offer online and offline courses on entrepreneurial failure (C10)
		Organizing various entrepreneurial competitions (C11)
		Hold a lecture/salon on entrepreneurship failure education (C12)
		Provide repair service for entrepreneurial failure (C13)
	Product evaluation	Enterprise education in colleges and universities has achieved high-quality development (C14)
		Entrepreneurs have a correct concept of entrepreneurial failure (C15)
		Ability to repair entrepreneurial failure is enhanced (C16)
		Enhanced the learning ability of entrepreneurial failure (C17)
		To improve the possibility of college students' entrepreneurial success (C18)

The EFE evaluation represents a dynamic and complex process, with the result-oriented appraisal system not able to portray the whole scenario of EFE fully. Though the CIPP model not only asserts the process but also pays sufficient attention to the results, thus, meeting the stipulated requirement [15]. Additionally, entrepreneurship education assessment is intended to discover and improve the drawbacks to optimize the influence of EFE, which is also in line with the “evaluation is for improvement” narrative held by the CIPP model [9]. Furthermore, a substantial body of literature attests to the efficacy of the CIPP model in assessing entrepreneurship education [4,25,40]. Consequently, the evaluation index system for entrepreneurial failure education proposed in this paper predominantly employs the CIPP evaluation model. Regarding the CIPP model, context evaluation needs to ascertain the goal determination's rationality and the actual needs of students' entrepreneurship. Hence, input evaluation warrants designing and choosing the best scheme to realize the goal. At this stage, inputting various schemes that achieve the set goal is essential while anticipating the pros and cons to determine the finest scheme. In addition, process evaluation presents a formative appraisal of the scheme implementation to adjust and perfect the specified implementation scheme. Further, product evaluation serves as a summative evaluation, which comprehensively utilizes different appraisal tools and techniques to confirm the scheme's implementation results and determine the extent to which the derived results materialize the goals and the satisfaction of the results. To sum up, the

CIPP model systematically adopts the assessment means and tools and obtains complete information with the help of quantitative and qualitative methods, consequently optimizing the teaching quality of EFE and giving full play to the maximum effectiveness of failure education. Thus, the CIPP model is an effective instrument for developing the appraisal index system of EFE in educational institutions.

From the perspective of defining the notion of EFE in educational institutions, drawing on Shen [25], Diao and Yu [4], Yang [40], and Zhang and Liu [51], and combining with the expert opinions in the area of entrepreneurship, this research paper adopts CIPP model to develop the index system of EFE which covers four significant aspects namely: background, input, process and outputs, and initially forms 26 indicators. Among them, the background level of EFE includes the institutional mechanism and organizational guarantee [4,25]. In comparison, input evaluation emphasizes the investment of entrepreneurial resources, such as entrepreneurial platforms, financial support, teacher construction, and practical and theoretical courses related to entrepreneurial education [4,40]. Furthermore, process evaluation chiefly includes teaching activities, including curriculum formation, curriculum system establishment, entrepreneurial salon, entrepreneurial competition, and repair service for entrepreneurial failure [44,51]. The results evaluation principally involves promoting entrepreneurial repair ability, high-quality development of entrepreneurship education, entrepreneurial failure cognition, ability to learn from failures, and entrepreneurial success [9,39].

Table 2. Descriptive statistics.

Variable	Category	Frequency	Percentage
Sex	Man	112	51.38
	Female	106	48.62
Age	30 and below	49	22.48
	31 to 35	67	30.73
	36 to 40	58	26.61
	41 and above	44	20.18
Professional title	Professor	12	5.50
	Associate Professor	65	29.82
	Lecturer	107	49.08
	Teaching Assistant	34	15.60
Education level	Postgraduate	35	16.06
	Bachelor	153	70.18
	College and below	30	13.76
Length of employment	2 and below	66	30.28
	3 to 5	75	34.40
	6 to 9	32	14.68
	10 and above	45	20.64
Teacher type	Counselor teacher	71	32.57
	On-campus entrepreneurial teachers	35	16.06
	Professional teachers	87	39.91
	Off-campus entrepreneurial teachers	25	11.47

Table 3. Questionnaire survey of entrepreneurship failure education in colleges and universities.

Primary index	Weight	Secondary index	Weight	Very strong	Strong	Generally	Weak	Very weak
Context evaluation B1	0.1075	C1	0.0708	27	91	55	34	11
		C2	0.2514	46	101	43	20	8
		C3	0.1637	41	98	41	24	14
		C4	0.5141	42	116	36	18	6
Input evaluation B2	0.1862	C5	0.0658	2	7	50	103	56
		C6	0.5571	9	28	69	78	34
		C7	0.1909	8	19	56	91	44
		C8	0.1862	5	9	35	113	56
Process evaluation B3	0.2836	C19	0.2290	7	23	84	65	39
		C10	0.1508	9	33	78	69	29
		C11	0.4406	16	36	83	61	22
		C12	0.1179	3	14	57	106	38
		C13	0.0617	2	11	61	104	40
Product evaluation B4	0.4227	C14	0.1320	4	17	72	94	31
		C15	0.2551	8	16	70	96	28
		C16	0.4814	5	9	55	113	36
		C17	0.0857	3	12	59	98	46
		C18	0.0458	4	18	60	97	39

3.2. Data collection

The questionnaire employed in this paper is compiled based on the evaluation index of EFE, Franke et al. [7], Souitaris [28] and Xu [36], which includes two major parts, namely: Basic information about teachers and main contents. On the one hand, the basic information of teachers contains age, degree, gender, working years, and professional title. On the other hand, the content consists of four dimensions, including background, process, input, and result, with 26 items. Furthermore, the Likert 5-point scale is adopted in this study, The scale from 1 to 5 represents degrees of conformity: ‘completely nonconforming’, ‘comparatively nonconforming’, ‘generally conforming’, ‘comparatively conforming’, and ‘completely conforming’. Based on the findings from the preliminary investigation, adjustments and enhancements were made to the items in the sub-table. Subsequently, an Entrepreneurial Failure Education (EFE) questionnaire comprising 18 items was developed, encompassing 4 items on the background of EFE [4,25], 4 items on the investment in EFE [4,40], 5 items on the process of EFE [44,51], and 5 items on the achievements of EFE [9,39]. Moreover, From July to September 2023, the college students of entrepreneurship education in five different universities in Shanxi, Hebei, and Jiangsu were chosen as the research objects, through random sampling, the number of questionnaires received from Taiyuan University of Science and Technology, Taiyuan University of Technology, Taiyuan Institute of Technology, Hebei Agricultural University, and Jiangsu University were 60, 43, 45, 55, and 33, respectively. Whereas 236 questionnaires were obtained through the online platform of Questionnaires; subsequently, 18 invalid questionnaires were removed, and 218 valid questionnaires are attained in this research study. Consistent with this, the essential condition of the research object is demonstrated in Table 2. The teachers engaged in entrepreneurship

education majorly possess intermediate titles and master's degrees. Further, these educators have been involved in entrepreneurship education for a short period. Most of the proposed educators are professional teachers and counselors in non-entrepreneurial fields.

Additionally, the validity and reliability tests confirm that the Cronbach coefficients of the total scale, the background component, the process component, the input component, and the outcome component stand at 0.941, 0.812, 0.799, 0.801, and 0.820, respectively, thereby, confirming the sound reliability of the research questionnaire. Likewise, the validity test of the questionnaire exhibits that the KMO value stands at 0.955, while the significance probability of the Bartlett sphere test is recorded at 0.000. Thus, the questionnaire validity also fulfills the statistical requirements.

The sorted data is populated in Table 3, consistent with the survey results of the sample of entrepreneurship failure education in the universities and colleges.

3.3. Determination of the Weight of Single-Level Sorting based on AHP

In order to quantitatively appraise EFE, this research study employs AHP, which combines quantitative and qualitative techniques to ascertain the weight of indicators at all levels in the assessment of EFE in universities and colleges. Since AHP is widely employed in the extant literature, we do not repeat the basic principle and operational steps.

The estimation steps of the weight of the first-level index evaluation system are below:

First, the judgment matrix is developed by AHP. Consequently, two teachers, three college entrepreneurs, and two entrepreneurs are invited from the Entrepreneurship Research Institute to ascertain each index's significance and derive the first-class index's judgment matrix, as illustrated in Table 4.

Table 4. A-B judgment matrix of primary indicators.

A	Context	Input	Process	Product
Context	1	3	1/6	1/8
Input	1/3	1	1/4	3
Process	6	4	1	1/7
Product	8	1/3	7	1

Second, after calculation, the first-level index weight vector W_0 equates (0.1075, 0.1862, 0.2836, 0.4227), with $\lambda_{\max} = 4.0166$, $CI = 0.0055$, $CR = 0.0062$, thus meeting the consistency requirements. Further, the results also fulfill the stipulations.

Similarly, the consistency test is conducted for the judgment matrix and weight of the secondary indicators, respectively. The background layer weight $W_1 = (0.0708, 0.2514, 0.1637, 0.5141)$, $\lambda_{\max} = 4.1110$, $CI = 0.0370$, $CR = 0.0416$; input layer weight $W_2 = (0.0658, 0.5571, 0.1909, 0.1862)$, $\lambda_{\max} = 4.0820$, $CI = 0.0273$, $CR = 0.0307$; process layer weight $W_3 = (0.2290, 0.1508, 0.4406, 0.1179, 0.0617)$, $\lambda_{\max} = 5.1161$, $CI = 0.0290$, $CR = 0.0259$; results layer weight $W_4 = (0.1320, 0.2551, 0.4814, 0.0857, 0.0458)$, $\lambda_{\max} = 5.2415$, $CI = 0.0604$, $CR = 0.0539$, and the relevant results are demonstrated in Table 3.

Table 5. The score of EFE in colleges and universities.

Primary index	Secondary index	Weighted score (weighted deduction)	Total weight score (total weight deduction)
Context evaluation	C1	0.5382 (0.2588)	7.6021 (3.1838)
	C2	1.9112 (0.7914)	
	C3	1.2445 (0.5153)	
	C4	3.9082 (1.6183)	
Input evaluation	C5	0.8664 (0.3588)	13.1675 (5.4525)
	C6	7.3356 (3.0376)	
	C7	2.5137 (1.0409)	
	C8	2.4518 (1.0153)	
Process evaluation	C19	4.5927 (1.9018)	20.0554 (8.3046)
	C10	3.0244 (1.2523)	
	C11	8.8364 (3.6590)	
	C12	2.3645 (0.9791)	
	C13	1.2374 (0.5124)	
Product evaluation	C14	3.9458 (1.6339)	29.8921 (12.3779)
	C15	7.6255 (3.1576)	
	C16	14.3901 (5.9587)	
	C17	2.5618 (1.0608)	
	C18	1.3691 (0.5669)	

Note: Weighted deduction = theoretical weight score-weighted score. The bigger the deduction item, the more it needs to be improved.

4. Fuzzy mathematical evaluation of the EFE

4.1. Deterministic evaluation set and fuzzy evaluation matrix

First, we draw on the notion of the 100-point system in the education field examination [17] utilizes the arithmetic score method $q_j = (n+1-j)*100/n$, ($j = 1,2,3,4,5$) to divide the comment set into five levels (Table 5), specifically expressed as follows: very strong (90–100), relatively strong (80–90), generally (70–80), relatively weak (60–70) and very weak (0–60). Additionally, the median value in a group is a sound representation of each group of data, and the assignment matrix C is assigned as follows: $C = (C1, C2, C3, C4, C5)$, where $C1 = 95$, $C2 = 85$, $C3 = 75$, $C4 = 65$, $C5 = 55$.

Second, the fuzzy evaluation matrix is determined in this study. Furthermore, statistical data based on the questionnaire survey can be obtained (Table 4): As per the fuzzy evaluation method, the primary evaluation vector can be obtained through calculation as follows, combined with the weight of secondary indicators and the data in Table 4:

$$B_1 = (0.1917, 0.4932, 0.1831, 0.0946, 0.0375),$$

$$B_2 = (0.0349, 0.0980, 0.2704, 0.4066, 0.1902),$$

$$B_3 = (0.0481, 0.1304, 0.3580, 0.3261, 0.1374),$$

$$B_4 = (0.0249, 0.0575, 0.2834, 0.4788, 0.1577).$$

A first-level evaluation matrix R is established as per B1, B2, B3, and B4:

$$R = \begin{bmatrix} 0.1917 & 0.4932 & 0.1831 & 0.1985 & 0.0375 \\ 0.0349 & 0.0980 & 0.2704 & 0.4066 & 0.1902 \\ 0.0481 & 0.1304 & 0.3580 & 0.3261 & 0.1374 \\ 0.0249 & 0.0575 & 0.2834 & 0.4788 & 0.1577 \end{bmatrix}.$$

Furthermore, the comprehensive evaluation vector can be obtained in accordance with the weight vector of the criteria layer factors: $W_0 = (0.1075, 0.1862, 0.2836, 0.4227)$:

$$B = W_0 \times R = \begin{bmatrix} 0.1075 \\ 0.1862 \\ 0.2836 \\ 0.4227 \end{bmatrix}^T \times \begin{bmatrix} 0.1917 & 0.4932 & 0.1831 & 0.1985 & 0.0375 \\ 0.0349 & 0.0980 & 0.2704 & 0.4066 & 0.1902 \\ 0.0481 & 0.1304 & 0.3580 & 0.3261 & 0.1374 \\ 0.0249 & 0.0575 & 0.2834 & 0.4788 & 0.1577 \end{bmatrix} \\ = [0.0513 \quad 0.1326 \quad 0.2914 \quad 0.3807 \quad 0.1450]$$

The evaluation value M of EFE in educational institutions can be derived by multiplying the comprehensive evaluation matrix B with the assignment matrix C ; explicitly, $M = B * C = (0.0513, 0.1326, 0.2914, 0.3807, 0.1450) * (95, 85, 75, 65, 55) = 70.7171$. In addition, the weighted scores and weighted deduction points of indicators at all levels of EFE in universities and colleges are estimated, while the relevant results are populated in Table 5.

4.2. Analysis of evaluation results

Since the maximum membership principle may be invalid, therefore, there is a need to compute the effectiveness of the maximum membership principle [55].

$$\alpha = \frac{n\beta - 1}{2\gamma(n - 1)}, \quad \beta = \max_{1 \leq i \leq n} \{b_i\}, \quad \gamma = \max_{1 \leq j \leq n, j \neq i} \{b_j\}$$

When α stands for infinite, the maximum membership principle is entirely adequate, whereas the proposed principle is highly effective when α is greater than or equal to 1. Moreover, the maximum membership principle is more effective when α stands at (0.5, 1). Similarly, the stated principle is inefficient when α is at (0, 0.5). Finally, the maximum membership principle is entirely invalid when it equates to 0.

Measuring the extent of membership when the principle of maximum membership fails is essential. Accordingly, the basic steps are as follows: ① First, there is a need to compute the highest score of comments $SH = \text{comment set} * (100, 90, 80, 70, 60)$; the lowest score $SL = \text{comment set} * (90, 80, 70, 60, 0)$. ② Second, $L = SH - SL$, L_i ($i = 1, 2, 3, 4, 5$) is measured, where L denotes the interval length where the evaluation result interval is very strong, relatively strong, general, weak, and relatively weak. ③ Third, the probability $P_i = L_i / L$, $i = 1, 2, 3, 4, 5$, of the evaluation result is calculated in each scoring interval, while the grade of the evaluation result is ascertained based on the P_i .

(1) Overall analysis of the appraisal results of EFE

Parallel to the aforementioned estimation results, the comprehensive judgment vector $B = (0.0513, 0.1326, 0.2914, 0.3807, 0.1450)$, and the effectiveness of the maximum membership principle is recorded to be 0.3876, less than 0.5, which shows that the maximum membership principle is the most inefficient, thereby raising a need to quantify it. The brief estimation is as follows:

$$(a) S_H = (0.0513, 0.1326, 0.2914, 0.3807, 0.1450) * (100, 90, 80, 70, 60)^T = 75.7221,$$

$$S_L = (0.0513, 0.1326, 0.2914, 0.3807, 0.1450) * (90, 80, 70, 60, 0)^T = 58.4601,$$

$$(b) L = S_H - S_L = 17.262, L_1 = L_2 = L_4 = 0, L_3 = S_H - 70 = 5.7221, L_4 = 60 - S_L = 60 - 58.4601 = 1.5399,$$

$$(c) P_3 = L_3 / L = 0.3315, P_5 = L_5 / L = 0.0892, P_3 > P_5.$$

In particular, the probability of ascertaining the grade as “general” is higher than the probability of judging the grade as “weak”. Therefore, the comprehensive evaluation result is assumed to be

“general” and more reasonable.

In addition to this, consistent with the relative weighted deduction in Table 5, it is evident that the weakest link in college EFE represents the achievement of college EFE, followed by the process, the input, and the background.

(2) Evaluation results of different dimensions of EFE

① Evaluation results of the context level of EFE

Based on the aforementioned estimation results, the background judgment vector $B1 = (0.1917, 0.4932, 0.1831, 0.0946, 0.0375)$, and the effectiveness of the maximum membership principle stands at 0.9561, which is greater than 0.5, suggesting that the maximum membership principle is adequate and there does not exist a need to scale its membership. Following the maximum membership principle of FCE, the state of the background level of EFE in higher education institutions is “very strong”.

Supported by Table 5, it is evident that the weakest link in the background of EFE is entrepreneurial policy, followed by the integration of EFE and talent training system, EFE atmosphere, and organizational guarantee.

② The evaluation results of the input level of EFE

In line with the above estimation results, the input level judgment vector $B2 = (0.0349, 0.0980, 0.2704, 0.4066, 0.1902)$, and the effectiveness of the maximum membership principle is reported to be 0.4777, lower than 0.5, which implies that the maximum membership principle needs to be gauged since the proposed principle could be more efficient. The brief computation steps are as follows:

$$(a) S_H = (0.0349, 0.0980, 0.2704, 0.4066, 0.1902) * (100, 90, 80, 70, 60)^T = 73.8083,$$

$$S_L = (0.0349, 0.0980, 0.2704, 0.4066, 0.1902) * (90, 80, 70, 60, 0)^T = 54.3007,$$

$$(b) L = S_H - S_L = 19.5076, L_1 = L_2 = L_4 = 0, L_3 = S_H - 70 = 3.8083, L_5 = 60 - S_L = 60 - 54.3007 = 5.6993,$$

(c) $P3 = L_3/L = 0.1952$, $P5 = L_5/L = 0.2922$, $P5 > P3$, since the probability of judging the grade as “very weak” is higher than that of “average”, therefore supposedly the comprehensive evaluation result is “very weak”.

In addition to Table 5, it is evident that the problem of EFE teachers indicates the weakest link in the investment level of EFE. However, the stated lead is followed by entrepreneurial platforms, practical and theoretical courses of EFE, and entrepreneurial funds.

③ The appraisal results of the process level of EFE

In accordance with the above calculation results, the decision vector $B3$ at the process level of EFE in higher education institutes = $(0.0481, 0.1304, 0.3580, 0.3261, 0.1374)$, while the effectiveness of the maximum membership principle stands at 0.3029, which is lower than 0.5; thus, reflecting that the maximum membership principle is inefficient and needs to be scaled. The brief estimation steps are as follows:

$$(a) S_H = (0.0481, 0.1304, 0.3580, 0.3261, 0.1374) * (100, 90, 80, 70, 60)^T = 76.2585,$$

$$S_L = (0.0481, 0.1304, 0.3580, 0.3261, 0.1374) * (90, 80, 70, 60, 0)^T = 59.3903,$$

$$(b) L = S_H - S_L = 16.8683, L_3 = S_H - 70 = 6.2585, L_5 = 60 - S_L = 60 - 59.3903 = 0.6097, L_1 = L_2 = L_4 = 0,$$

(c) $P3 = L_3/L = 0.3710$, $P5 = L_5/L = 0.0361$, $P3 > P5$. This means that the probability of ascertaining the grade as “average” is higher than the probability of judging the grade as “very weak”, therefore it is assumed that the comprehensive evaluation result as “average” is more reasonable.

From the perspective of Table 5, the entrepreneurial competition presents the weakest link in the process of EFE, followed by EFE courses, online and offline courses, entrepreneurial lectures, and so

forth.

④ The assessment results of the product level of EFE

Parallel to the aforementioned calculation results, the judgment vector B4 of the achievement level of the EFE = (0.0249, 0.0575, 0.2834, 0.4788, 0.1577), whereas the effectiveness of the maximum membership principle stands at 0.6148, higher than 0.5, which infers that the maximum membership principle is effective. Consequently, it is optional to measure its membership. Furthermore, the background level of EFE is “relatively weak”, per the principle of maximum subordination of fuzzy evaluation.

Additionally, the weakest link in the achievement level of EFE represents the ability to repair entrepreneurial failure, followed by entrepreneurial failure cognition, high-quality development of entrepreneurial education, and entrepreneurial failure learning ability, based on the relative weighted deduction in Table 6.

5. Conclusions

In this paper, the CIPP model is integrated into the evaluation system of EFE in universities and colleges. Based on the related research on the evaluation of entrepreneurial education, the connotation of EFF in educational institutes, and the practice of entrepreneurial failure of college students, an evaluation index system of EFE in universities and colleges are built through early primary selection and late improvement. For this purpose, the evaluation framework of EFE in educational institutes is developed based on the AHP and FEC. Furthermore, five universities and colleges in Hebei, Shanxi, and Jiangsu are utilized as research samples to appraise EFE. The study findings demonstrate that according to the principle of maximum membership, EFE in China’s universities and colleges is in a “weak” state as a whole, in which the context, input, process, and product are in a “strong” “weak” “general” and “weak” state in turn; According to the calculation of the effectiveness of the maximum membership principle, the overall state of entrepreneurship failure education in colleges and universities in China is revised as “general”. The context, input, process, and product are revised as “strong”, “very weak”, “general”, and “weak”, in turn (see Table 6). This study provides an effective evaluation tool for EFE in colleges and universities, enriches the research on the evaluation of EFE in colleges and universities, and provides a decision-making basis for improving EFE in colleges and universities.

Table 6. The summary of the main conclusions.

Maximum membership principle		The effectiveness of the maximum membership principle	
Efe	Weak	Efe	General
Context	Strong	Context	Strong
Input	Weak	Input	Very weak
Process	General	Process	General
Product	Weak	Product	Weak

6. Implications

Based on the evaluation results of EFE in universities and colleges, there is a dire need to optimize further the management capability of college students’ entrepreneurship failure, curriculum design of

entrepreneurship failure, entrepreneurship practice training, entrepreneurship teacher construction, and system perfection and execution.

First, in terms of the product, emphasis must be paid to not only strengthening the ability to repair entrepreneurial failure but also the ability to recognize entrepreneurial failure. Therefore, higher education institutions should cultivate a tolerant environment of entrepreneurial failure, establish a proper concept of entrepreneurial failure, improve the psychological capital level and failure management ability of college entrepreneurs, and encourage college students to understand the value of entrepreneurial failure correctly [54]. Furthermore, support and encourage college students to learn from entrepreneurial failure, cultivate entrepreneurial resilience, enhance their ability to resist setbacks, repair negative emotions, effectively manage the cost of failure, and enhance the willingness, ability, and success rate of subsequent entrepreneurship.

Second, in the context of the process, there should be a focus on all types of entrepreneurial competitions in universities and colleges while establishing a curriculum system for EFE. Therefore, educational institutes need to extend related knowledge- and practical training for college students to participate in competitions and raise funds through various channels to ensure sufficient financial, human, and material support. Further, entrepreneurial competitions must be organized at all levels, including schools, provinces, counties, states, and countries. In addition, there is also a substantial need to improve the curriculum system of EFE, highlight the distinctness and comprehensiveness of the entrepreneurship failure curriculum while clarifying that the core concern of the entrepreneurship failure curriculum is to recover from the grief of entrepreneurship failure through entrepreneurship failure learning, improve the willingness to commence a business again, and the prospect of entrepreneurship success that covers the nature, attribution, repair, and learning of entrepreneurship failure.

Third, from the perspective of input, sufficient focus should be placed on the teachers, courses, and platforms of EFE. It is crucial to adopt the principles of “combining introduction with training” and “not seeking everything, but seeking application” to expand the contingent of entrepreneurial teachers, launch entrepreneurial talents, and constitute the influence of entrepreneurial teachers’ talents gathering. Moreover, it is necessary to improve entrepreneurial teachers’ professional level and practical ability through various training, study, and study visits, improve the quality of entrepreneurial teaching and the ability of entrepreneurial practice guidance, and provide sufficient talent support for EFE. Additionally, there is a need to strengthen the development of an entrepreneurship platform to extend training locations for college students’ entrepreneurship education to enhance the entrepreneurial experience and practical ability while paying due attention to the top-level design, planning the curriculum system of EFE as a whole, and selecting or compiling the high-quality planning teaching materials. as well as innovating teaching methods and encouraging the use of situational teaching, role-playing, participation in teaching, conversation, practice, discussion to improve the quality of entrepreneurship teaching in an all-round way.

Last, from the context standpoint, sufficient measures must be taken to implement entrepreneurship policy and bring EFE into the talent training system in educational institutes. Consequently, universities and colleges need to establish an education department for entrepreneurial failure, responsible for EFE’s overall planning, policy revision, and supervision, increase the publicity and support for entrepreneurial policies, and provide organizational and institutional guarantees. Additionally, it is compulsory to realize the significance of EFE further, roots the factors of failed education in the entrepreneurial education system and establishing healthy entrepreneurial values,

cultivate college students' entrepreneurial failure management ability, entrepreneurial spirit, and innovation ability, and promote their all-round and sustainable growth, and integrate EFE with talent training, based on the all-round development of "morality, intelligence, physique beauty, and labor".

7. Limitations and future directions

We present only a preliminary exploration of the EFE evaluation in educational institutions. Although the connotation of the EFE has been analyzed and the assessment research on the EFE has been performed, developing the EFE in universities/colleges is a dynamic process. There are differences among different universities and colleges, and the evaluation index system is subjective and does not reflect the time change, which belongs to a static perspective. Therefore, future studies should emphasize the level of EFE in different stages and types of universities and colleges. In line with the CIPP model, the primary aim of appraisal is to promote and develop entrepreneurship education. When further promotion of the EFE level is considered, it becomes urgent to study its influencing factors and relevant mechanisms. In contrast, the dynamic quantity of the development level of EFE in universities and colleges represents a direction worthy of future study. Furthermore, the sample size in this study is slightly inadequate, and the representativeness of the sample requires further enhancement. Thus, it is essential to increase the sample size and refine the sampling methodology in future research endeavors.

Author contributions

Chaoyong Tang: Conceptualisation, Writing – original draft, Formal analysis, Supervision; Sunli Sun: Software, Writing review & editing, Validation; Wanming Chen: Writing review & editing, Validation. All authors have read and agreed to the published version of the manuscript. These authors contributed equally to this work.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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