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Exploring the Entrepreneurial Intentions of Science and Engineering Students in China: A Q Methodology Study

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Abstract: The entrepreneurial intentions of Chinese students have received rapidly evolving attention, with the "mass entrepreneurship and innovation" program as a driving force, which encourages individuals to start their own business. Entrepreneurial intention, which is perceived as being a predictor of entrepreneurial behavior, has generally been explored in the existing literature on the basis of the theory of planned behavior and the intention–behavior model. Since intention is a psychological notion, it is important to investigate the motivation for developing entrepreneurial intention from a subjective perspective. The aim of this study is to identify the objective factors that determine Chinese science and engineering students' entrepreneurial intentions, and to understand how these different factors affect their intention to become an entrepreneur. Q methodology, which is a technological combination of qualitative and quantitative research, was conducted using thirty Chinese science and engineering students, and this paper reports their individual attitudes and discourses concerning their entrepreneurial intentions. After compiling 32 Q sets of statements and performing factor analysis, three distinct types of entrepreneurs were revealed. The findings suggest that a subjective approach to entrepreneurship education should be taken to enhance science and engineering students' entrepreneurial intentions. Some theoretical and practical implications of these findings for techno-entrepreneurship education and development are also discussed.

Keywords: entrepreneur; entrepreneurial intention; entrepreneurial education; Q methodology; mixed-methods; qualitative

1. Introduction

Entrepreneurship has been widely perceived to be an important source of economic growth for nations [1,2], because it drives new business creation and venture launches [3,4]. Since it fosters job creation, promotes sector productivity, and facilitates social mobility [3], it has received a great deal of attention from both academic and practical fields. Researchers of entrepreneurial studies have spent a lot of time trying to discover the factors that promote entrepreneurship, and the influences of these factors. Empirical studies have revealed that early-stage entrepreneurial intention is an important factor that stimulates a series of entrepreneurial activities [5].

It has been demonstrated in the psychological literature that intention is the best predictor of behavior, especially when that behavior is rare, difficult to identify or predict, or includes uncertainty. Entrepreneurial activity is a typical example of such planned, intentional behavior [6–8]. Entrepreneurial intention as a distinct and inter-related concept is defined as the commitment to starting a new business [9], and it plays a role of the utmost importance in the first stage of the entrepreneurial process.

As a result of this, there has been an increasing number of publications on studies of entrepreneurial intention. According to previous research, factors such as personal-level variables, entrepreneurship education, an entrepreneurship environment, and the entrepreneurial process influence an individual's intention to be an entrepreneur [10].

The prevailing entrepreneurial activity outcomes of entrepreneurship education have led to its promotion and implementation in higher education programs across many countries [11]. A more systematic approach to education would help to improve participants' identification of entrepreneurial opportunities and their perseverance in pursuing sustainability, making up for deficiencies in the market of relevant entrepreneurial potential [12]. In recent years, the concept of sustainable entrepreneurship has become prevalent worldwide [13]. It involves three dimensions, namely, financial, social, and environmental aspects. In China, sustainable entrepreneurship boosts the sustainable development of the economy and society, and protects the ecological environment [14]. Entrepreneurship education aims to shape a sustainable entrepreneur [13] by providing a platform for entrepreneurs and promoting students' intents to start a business.

Researchers have tried to analyze the determinants of entrepreneurial intention from different perspectives. Nevertheless, in China, the previous research on entrepreneurial intention has lacked subjective perspectives. Therefore, using Q methodology, we aimed to find the factors that influence the intention to start a business.

The contribution of this paper is its application of Q methodology, which is a combination of qualitative and quantitative research and was used in this study to help understand the subjective opinions of Chinese science and engineering students regarding their entrepreneurial intentions. Although there have been similar studies conducted in this field, Q methodology has yet to be applied to this topic. The aim of the present study is to identify and categorize Chinese science and engineering students' perceptions of entrepreneurial intention.

The reason we chose such a selective research topic, i.e., specific to Chinese students majoring in science and engineering, is as follows. First, the Chinese government has set a goal to become the "top innovative nation" by 2020. This strategy promotes entrepreneurship and makes industry the driver of innovation. Entrepreneurship education programs in engineering education are highly encouraged to meet the preconditions of technological advancement [15]. According to previous research, compared with students majoring in business, students with non-business majors had stronger sustainability-oriented entrepreneurial intentions, and they treated entrepreneurship more positively [16]. Thus, we used science and engineering major students as an example. Second, the combination of innovative education and entrepreneurship education in colleges has been prevalent in China, and colleges have proposed that employment could be promoted by means of entrepreneurship in some way. In addition, college students could be seen as groups of potential entrepreneurs, who are the driving force of innovation and entrepreneurial activities. Additionally, earlier research has illustrated that Chinese students have relatively strong motivation and intentions to become entrepreneurs [17]. Therefore, we focused on college students majoring in science and engineering, and intended to find a way to enhance their motivation to innovate and start businesses.

The remainder of this paper is structured as follows. Section 2 presents a review of the extant literature related to entrepreneurial intention; Section 3 describes the Q methodological approach; Section 4 contains the details of data analysis and presents the results; Section 5 discusses the results; and Section 6 concludes the paper and summarizes some limitations, while offering some recommendations and implications for further research and practice.

2. Literature Review

2.1. Entrepreneurship and Entrepreneurial Intention

Entrepreneurship can be defined as the process of discovering, evaluating, and exploiting an opportunity [18]. Entrepreneurship is a behavior that creates new economic entities, and it is an

important boost to national economic growth. Entrepreneurs increase productivity through different levels of innovation and sell products using novel marketing strategies. The main innovation task of an individual who is characterized as an entrepreneur is to break up old traditions and create new ones. The entrepreneurial process can accelerate economic transformation and promote national economic development until the country is considered a permanent innovator [19]. Similarly, as an economy develops and grows, more resources are available for the creation of new ventures [20].

Behavioral studies have pointed out that intention is a necessary precondition of action. The early literature on intention has proven that it is more appropriate than other factors to explain behavior [21], and it is considered to be the immediate antecedent of behavior. In the field of social psychology, many social behaviors, such as entrepreneurship, can best be predicted on the basis of intention [22–24]. In this sense, entrepreneurial intention would be a decisive factor in the performance of entrepreneurial actions [25].

The theoretical approach to entrepreneurial intention started with Shapero, who proposed the concept. Shapero underlined that entrepreneurial intention is the intention to engage in business activities and achieve self-employment, and it refers more to those who intend to conduct high-growth business [26]. It is a psychological process that predicts behavior and reveals attitudes, beliefs, and effective actions [10]. Bird identified the intention of entrepreneurship as a mental state that directs the attention, energy, and behavior of entrepreneurs to specific business goals, and the realization of entrepreneurship must be inspired by the intention to do so [5]. Thompson defined entrepreneurial intention as the self-motivation to establish a new business enterprise and the conscious attainment of a certain level of entrepreneurship in the future [27]. For entrepreneurs, opting to start a business is not an accidental decision, nor is it the result of someone telling them to start a business. Entrepreneurial activity can be seen as a career choice, in which entrepreneurs choose a specific product or service around which they organize resources to implement this choice [5]. Entrepreneurial intention is regarded as the product of personal self-efficacy, attitude, and subjective norms of entrepreneurial behavior [28]. Entrepreneurial intention is the key to understanding the entrepreneurial process, and it is the first step in the long and complex entrepreneurial process [9].

Since the number of studies on entrepreneurial intention started to increase, the most frequent approaches to the topic have been examining the formation mechanism and influencing factors of EI (entrepreneurial intention) from different perspectives and a series of representative theoretical models. Ajzen's Theory of Planned Behavior has become the most well-validated model; it states that personal attitudes, subjective norms, and perceived behavioral control are the antecedents of intention formation [22], and it emphasizes that intentions predict behavior and that certain specific attitudes predict intention [29]. It further points out that any behavior needs planning, and intention serves as a mediator variable between the act of starting a new venture and potential exogenous influences [28]. Shapero and Sokol's Entrepreneurial Event Model (SEE) is based on the fact that inertia guides human behavior until something interrupts or "displaces" that inertia [26]. The SSE proposes that perceptive feasibility or perceived perception and perceived desirability are two key factors that influence an individual's entrepreneurial intention [30]. Perceived desirability refers to the personal attraction to starting a business, and includes both intrapersonal and extra-personal impacts. Perceived feasibility is defined as the degree to which the individual feels they are personally capable of starting a new venture [28]. Popescu et al. found that different determinates included in the TPB (Theory of Planned Behavior) and SEE have a significant and positive effect on the intention to start a business in the future [31]. The model of goal-directed behavior maintains the basic framework of the TPB, and it expands the understanding of integrating willing behavioral and behaviors that target directed goals [32]. According to the existing literature, the most powerful theory that explains and facilitates the understanding of entrepreneurial intention is the combination of the TPB and perceived desirability. In the extended model of goal-directed behavior, perceived desirability would be considered the desire to conduct an activity that moves towards the goal of being an entrepreneur. Similarly, in the SEE, desires are equivalent to the perceived desirability. Therefore, the extended

model of goal-directed behavior is treated as a new fusion between the conceptual frameworks of the TPB and SEE [33]. Wu and Wu argued that entrepreneurial feasibility perception and desirability are essential parts of entrepreneurial intention in the prediction of entrepreneurial activity [34]. From a personal characteristic approach, it was found that the personality of an individual is the only factor that affects entrepreneurial intention [12].

Previous research has stated that entrepreneurship education can enhance an individual's level of self-efficacy [35]. Souitaris et al. [36] found that entrepreneurship education programs significantly improve students' subjective norms and intentions toward entrepreneurship, and they are also the source of entrepreneurial attitudes and intentions to become future entrepreneurs and start new ventures. Besides this, entrepreneurship education increases the entrepreneurial intentions of college students to a high level.

A distinction should be made between the concepts of entrepreneurial orientation and entrepreneurial intention: entrepreneurial orientation has been widely recognized as a firm-level attribute that determines a firm's performance and represents the thoughts and perspectives on entrepreneurship and innovation. In recent years, some studies have extended this concept to the individual level in what is known as individual entrepreneurial orientation (IEO), which includes five dimensions: (1) autonomy; (2) risk-taking; (3) proactiveness; (4) competitive aggressiveness; and (5) innovativeness [37].

2.2. Entrepreneurship Education

In the early 1980s, entrepreneurship education began in force in business schools, and it was thought to be learnable, similar to any other discipline [38]. Over the next two decades, entrepreneurship education in universities developed considerably around the world. Entrepreneurship education is distinguished from general education because the former specifically aims to promote entrepreneurial abilities and increase entrepreneurial knowledge [39]. Entrepreneurship education is defined as the "means of promoting the transformation of ordinary people into entrepreneurs who are aware of future opportunities to make a career by creating profitable mini-companies" [40]. It consists of courses and programs that teach entrepreneurial attitudes and qualities [41].

Further studies have found a strong relationship between entrepreneurship education and entrepreneurship skills and intentions. Crant noted that education was significantly associated with entrepreneurial intention [42]. Franke and Luthje found that the less distinctive entrepreneurship education received by students, the lower the level of their start-up intentions [43]. Entrepreneurship education programs inspire students to enhance their entrepreneurial attitudes and intentions [36]. Compared with students who do not participate in entrepreneurship education, participating students exhibit stronger intentions [44]. According to Nabi et al.'s systematic review of entrepreneurship education, 75% of 81 reviewed articles reported a positive link between entrepreneurial education and participants' start-up intentions [45]. However, some studies have also indicated that entrepreneurship education does not translate to entrepreneurial intention.

2.3. Entrepreneurship Education in China

Entrepreneurship education in China started in the early 1990s. Initially, entrepreneurship education in China originated from "management education and selective MBA modules" [46]. Later, a pilot project was launched in nine selected universities across China, with the aim to spread entrepreneurship courses, talent training, and business plan competition. Until then, entrepreneurship education had remained an individual institutional practice, and the nine pilot universities gave it a different focus. A systematic entrepreneurship education program named Know about Business (KAB) took and guided the market, and it has been well recognized. In 2005, the program helped students better understand how to become an entrepreneur and resulted in more attention being paid to "entrepreneurial spirit" education [47]. In 2008, the government called for several governmental agencies, universities, and enterprises to set up a pilot scheme to develop entrepreneurial talent

and innovation [48]. With more engagement and increased attention being paid to entrepreneurial activities, entrepreneurship education in China has continuously progressed to satisfy practical requirements. It adapts to the "requirements of the construction of an innovation-oriented country and the development of high-quality education." As a systematic project, the perfection of entrepreneurship education needs the engagement of the economy and management as well as the perfection of the education model [49]. The primary purpose of entrepreneurship education in China is to cultivate students' entrepreneurial talents and skills, and it must be adaptable to the socioeconomic development of the country [50].

Entrepreneurship education in China is also focused on fostering students' positive and creative attitudes and intentions toward starting a new business venture. Zhang et al. carried out empirical research to establish a relationship between entrepreneurship education and entrepreneurial intention, and they instructed policymakers and university managers to place more emphasis on students with technological majors [51]. Wu and Wu pointed out that academic major is an important factor that influences entrepreneurial intention, and engineering students have the highest intentions to start new business ventures [34]. Compared with developed countries, the impact of entrepreneurship education on Chinese students is nearly equal [52].

Strengthening the impact of entrepreneurship education on students' entrepreneurial intention requires analysis of this issue from the perspective of students: this is indispensable to broadening the dimension of entrepreneurship education. Our study aimed to apply a subjective research methodology to find the interrelation between entrepreneurship education and entrepreneurial intention. Recent research has drawn attention to the need for spreading entrepreneurship education in the engineering and science departments, from which most technologies originate [53], because the technology sector plays a significant role in the national economy.

3. Methodology

A review of the existing literature to date, however, suggests that the factors that influence the entrepreneurial intention are absent from the dimension of subjective perception. Therefore, we propose that targeting the subjective perceptions of the students themselves is of the utmost importance to answering the question of interest to entrepreneurship educators and policymakers: What can be done to cultivate entrepreneurial intentions?

To date, research has yet to focus on entrepreneurial intention from this perspective, and this study aims to fill this gap in the literature and practice. Q methodology as a research method remains underutilized in the study of entrepreneurship and entrepreneurial intention; therefore, this study provides a valuable methodological contribution.

Q methodology (Q) is a mixed technique that was developed by William Stephenson. It aims to investigate human subjectivity systematically and holistically; it clarifies a subject's perspective about a phenomenon, interest, or concern, and it was designed to present clusters of a group of individuals' opinions, ideas, beliefs, comments, and values [54,55]. Q has also been proposed for understanding how individuals come to know and make meaning and sense of their worlds from their own perspectives and experiences [56]. Q methodology is distinguished from R methodology, known as a traditional statistical technique, by its combination of the advantages of both qualitative and quantitative research. Q method inverts factor analysis to by-person as well as by-variable analysis, which can be viewed as the analytic core of Q [57]. Baker and his associates captured this particular strength of Q methodology: Q methodology is an approach that avoids researchers' bias to a large extent, and makes the participants' opinions known distinctly (but largely uncensored) [58].

Although the technique has been relatively less-known and underutilized in the mainstream social sciences, Q methodology is a particularly suitable tool for approaching the subjective perception of students' entrepreneurial intentions because "it is unique in being largely driven by the participant's responses," and this special quality makes it more appropriate for discovering the subjectivities of a group of individuals [59].

Generally speaking, with Q methodology applied successively, the researcher collects the viewpoints, establishes the perspectives, understands the implications, elucidates the ideas, and makes comparisons [60]. The procedure of conducting the Q method is shown in Figure 1: (1) compiling the concourse of the given topic from diverse materials; (2) establishing a representative set of statements (Q sample) that are a compressed version of the larger concourse; (3) selecting the participants for the study (P-sets) who want to say something about the topic [60]; (4) completing the Q sort (rank-ordering of statements); (5) factor analysis and interpretation.

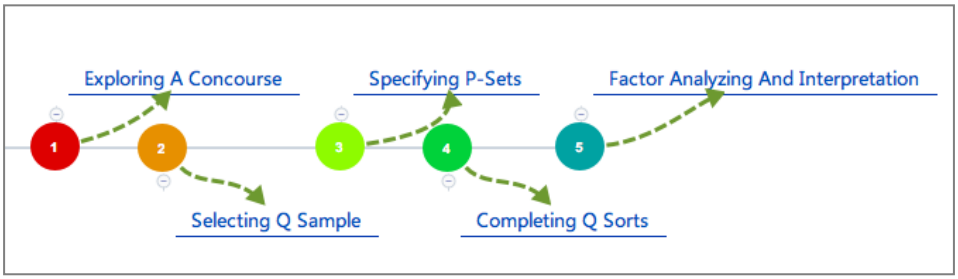

Figure 1. Steps of Q methodology.

3.1. Development of Concourse

The first step of Q methodology is the development of a concourse, which is in essence a collection of the raw materials that contain statements and subjective viewpoints. According to Brown, a concourse may be derived from a variety of sources, including articles in the literature, interviews, focus groups, newspapers, talk shows, media reports, and opinions of both experts and laypeople. However, the typical way a concourse is collected is by interviewing people [61]. Q researchers collect a specific concourse and then construct a representative set of items [54]. For this study, the concourse was collected in order to reflect a range of opinions on entrepreneurial intention among students. An online questionnaire was conducted at a public university that has more than 20,000 students in the Jiangsu Province of China, and 123 students completed the questionnaire from March to June 2018. Before that, eleven volunteers helped us accomplish a pilot test, which included a face-to-face, in-depth interview and questionnaire; open questions, such as "What factors will influence your entrepreneurial intention?" and "Please tell me your opinions about entrepreneurial intention," were asked to clarify some Q statements, which became known as the concourse of students' perspectives on entrepreneurial intention. Through this procedure, some iterative or analogous opinions were deleted, and, finally, 40 statements were extracted.

3.2. Establishment of Q Sample

A subset of statements that are selected from the larger concourse for a particular study is called the Q sample. The statements that form the Q sample should be selected to be representative of the full diversity of viewpoints by following the principle that categorizes statements into methodological or technical, or by employing content analysis [61,62]. A Q set (Q sample) may comprise objects, declarations, features, descriptions, and so on [55]. In this research, 40 statements were collected to reflect the perceptions of impacts on entrepreneurial intention. Content analysis, which is a common way to choose a Q set from a large concourse, involves various dimensions related to the topic [62]. Here, four dimensions ("personal issue variables; social issue variables; family issue variables; and college issue variables") of individual viewpoints about entrepreneurial intention were covered, and statements were categorized according to the similarities, differences, and common characteristics. Ultimately, a sample of 32 statements remained as the structured and balanced Q sample (Q set), which was established from the students' opinions on entrepreneurial intention. Besides other advantages, this research avoids the "sorting fatigue" that participants often experience.

3.3. Selection of P-Sets

P-sets are the participants who conduct the Q sort. Q methodologists typically use a very strategic approach to recruiting an appropriate number of participates who hold diverse ranges of opinions [57]. Given that students majoring in science and engineering have diverse attitudes toward influencers of entrepreneurial intention, it was important to sample from different regions. In this study, a purposeful sampling strategy was employed to make the sample more credible. Next, to represent the campus-wide variability in perspectives on entrepreneurial intention, the research participants were purposefully selected from science and engineering students who have entrepreneurial intentions or have already started entrepreneurial activities; the selection was based on interviews. The snowball sampling method was employed to select 34 college students from different universities in six cities: Huai'an, Nanjing, Fuzhou, Nanning, Shanghai, and Zhenjiang. The snowball sampling method is a technique in which participants recruit or recommend other study participants from among their acquaintances, so the process is similar to a rolling snowball. It started with students who had high entrepreneurial intentions; they were asked to recommend other students who would be good participants [63]. Those who were likely to become entrepreneurs, who were in the startup stage, or who had strong entrepreneurial intention were the final P-sets. The participants ranged from 18 to 28 years old; 25 were males and 9 were females, in accordance with the diversity of P-sets. After the research participants (P-sets) were selected, the instrumental basis of Q methodology was implemented, i.e., the Q sort technique. This step involves the rank-ordering of a set of statements by the participants from "most agree" to "most disagree" [61].

3.4. Q Sorting

The fourth stage of Q is the ranking procedure, which is always known as Q sorting. Here, the 34 participants sorted the statements into a response grid (see Table 1) into nine categories, i.e., from most disagreeable (−4) to most agreeable (+4), as well as neutral, which was represented by 0. They sorted the 32 statements into a forced normal distribution, which was defined by the nine categories (statements scored as −4, −3, −2, −1, 0, +1, +2, +3, +4), with a specified number of items assigned to each ranking position (in this study, two items were in the /4 position, two in /3, four in /2, five in /1, and six in /0). Finally, 4 valid sorts were eliminated because of some sorting mistakes, and we obtained 30 Q sorts.

Table 1. Q sorting.

Most Disagree				**Neutral**				**Most Agree**
−4	−3	−2	−1	0	1	2	3	4

3.5. Q Factor Analysis

In Q research, "the factor analysis is to invent a few new variables which explain variation in many variables" [62], and the variables in Q are the participants' Q sorts. Factor analysis is a method that aims to reveal patterns of association among a series of measured variables [57]. PQMethod software (version 2.35) is a program used for implementing factor analysis. Q sorts were analyzed in PQMethod software, which facilitates data input, automatically generates a correlation matrix, and directly performs factor extraction, rotation, and estimation [64]. Factors are operant combinations of similar people [58]. This procedure aims to assess the correlations among every individual's Q sorts. Three statistical procedures of data analysis are included in Q methodology: (1) correlation and factor analysis, (2) factor array, (3) and factor interpretation [54].

As stated above, 34 Q sorts were collected, but four were discarded as a result of students' clerical errors. Thus, 30 Q sorts in total were factor-analyzed using PQMethod software [65]. Principal component analysis of the Q sorts produced eight factors that explained 76% of the study variance. A Q centroid manual rotation was performed in this study to select the number of factors to be rotated, because it is the preferred factor extraction method in Q methodology [61,64]. This produced three significant factors, which are discussed in the following Results section.

4. Results

The students who participated in this study displayed three distinct perceptions of entrepreneurial intention that classified them into one of three types: (1) Intellectual Entrepreneur; (2) Opportunity-Driven Entrepreneur; and (3) Individualistic Entrepreneur. In the data analysis by the PQ program, the loaded factors of Q sorts were reconstructed and then weighted to aid in the interpretation of the results. Distinguishing statements were extracted from the analysis for each factor, highlighting items that were treated differently by participants [54,60]. The outcome of the factor analysis is presented in Table 2. The extractions from the unrotated factor matrix accounted for 47% (16% + 18% + 13%) of the total variance. Twenty six of the 30 Q sorts loaded significantly on one or more of the three factors. Here, the results showed that the participants were confident that they accurately reflected their opinions. The distinguishing statements of each perception type are highlighted below, as are the characteristics of the participants who defined each perspective.

Table 2. Factor loadings by participant and opinion type (*).

ID	Factor A	Factor B	Factor C
2	60		
5	42		
7	46		
13	50		
20	62		
24	70		
25	52		
26	69		
28	79		
3		61	
6		52	
8		66	
14		78	
15		51	
16		64	
18		72	
19		45	
27		55	
1			41
9			75
10			72
11			49
12			67
23			60
29			47
30			44

(*) only significant loadings are shown ($p < 0.01$); decimals omitted.

4.1. Factor A (Intellectual Entrepreneur)

Factor A (see Table 3) had an eigenvalue of 8.23 and accounted for 27% of the study variance. Nine participants, which represented 34.6% of the P-sample with 7 males and 2 females, exemplified this factor. Six of them were aged between 18 and 22, and the remaining three were aged between 23 and 26.

From the different scores that the participants gave to the statements, we found that the students in this group may be more intellectual and thoughtful when trying to start a business because they have strong attitudes toward rebuilding self-confidence after an entrepreneurial setback, which is a must-have trait for entrepreneurs (Statement 25: +4). Therefore, their perspectives on the first step of entrepreneurship were to positively respond to failure and remain optimistic. They also had strong interests in starting a business (Statement 2: +3). Generally speaking, interest is a good teacher of a subject. From the opinions of this group, business opportunity and market timing were important factors of successful entrepreneurship (Statement 27: +3). They were also willing to accept the government's supportive policies, such as venture capital; these were good lures for them (Statement 17: +3). In addition to these resources, the accumulation of a person's social capital, such as interpersonal relationship, opportunities, resources, markets (Statement 6: +2), also enhanced their entrepreneurial intention and was considered a successful part of entrepreneurship.

They maintained neutral attitudes on the effect of entrepreneurship education and training courses (Statement 14: 0), i.e., they were neither against nor supportive. They also thought that there is no difference between male and female intellectual entrepreneurs (Statement 5: −4). Furthermore, they stated that they would not be confused by propaganda containing a large amount of entrepreneurial information (Statement 19: −3). The students in this group did not participate in the school's entrepreneurial competition because they thought it had no value (Statement 4: −3), and they would not be driven to start a business because of employment pressure (Statement 31: −3).

Table 3. Q statements of the three factors used in this study.

Factor A: Intellectual Entrepreneur		
No.	**Q Statement**	**Score**
25	The ability to rebuild self-confidence after a setback.	+4
2	The one who has strong interests in staring a business will have strong entrepreneurial intention.	+3
27	Business opportunity and market timing are important.	+3
17	The government's supportive policies such as venture capital will make students think of starting a business.	+3
6	The accumulation of a person's social capital would affect his entrepreneurial intention, such as interpersonal relationship, opportunities, resources, markets.	+2
16	Technological entrepreneurship requires the support of technology. Once technology is available, the intention will be stronger.	+1
14	Participating in entrepreneurship education and training course provided by the school will increase my entrepreneurial intent.	0
19	The propaganda of a large amount of entrepreneurial information made us want to have a try.	−3
4	Participating in the school's entrepreneurial competition will has an impact on one's entrepreneurial intention.	−3
31	If you can't find a job after graduation, you may want to start a business when you are under employment pressure.	−3
5	Gender will affect entrepreneurial attitudes.	−4
Factor B: Opportunity Driven Entrepreneur		
No.	**Q Statement**	**Score**
22	If you find a suitable entrepreneurial project or accurate business direction, it will affect your intention.	+4
21	Your partner and your future team member are important.	+3
20	Money is an important factor.	+3
6	The accumulation of a person's social capital would affect his entrepreneurial intention, such as interpersonal relationship, opportunities, resources, markets.	+3
16	Technological entrepreneurship requires the support of technology. Once technology is available, the intention will be stronger.	+2
14	Participating in an entrepreneurship education and training course provided by the school will increase my intent.	−3
31	If you can't find a job after graduation, you may want to start a business when you are under employment pressure.	−3
9	Different age groups have different entrepreneurial intentions.	−3
18	The government provides entrepreneurial skills training in college, such as SYB * courses, which will enhance my entrepreneurial intentions.	−4

Table 3. *Cont.*

(*) SYB's full name is "START YOUR BUSINESS", which means "Start Your Business". It is an important part of the "Starting and Improving Your Business" (SIYB) series of training courses, which provides training for those who want to start their own small and medium enterprises.

Factor C: Individualistic Entrepreneur		
No.	**Q Statement**	**Score**
2	The one who has strong interest in staring a business will have strong entrepreneurial intention.	+4
3	Different educational backgrounds and the intentions of starting a business will be different.	+3
8	An individual must have the ability to start a business.	+3
6	The accumulation of a person's social capital would affect his entrepreneurial intention, such as interpersonal relationship, opportunities, resources, markets.	+3
16	Technological entrepreneurship requires the support of technology. Once technology is available, the intention will be stronger.	+2
9	Different ages have different entrepreneurial intentions.	−3
19	The propaganda of a large amount of entrepreneurial information made us want to have a try.	−3
29	Part-time job experience will influence entrepreneurial ideas.	−3
31	If you can't find a job after graduation, you may want to start a business when you are under employment pressure.	−4

4.2. Factor B (Opportunity-Driven Entrepreneur)

Factor B (see Table 3) had an eigenvalue of 3.16 and explained 11% of the study variance. Nine participants, which represented 34.6% of the P-sample with 7 males and 2 females, exemplified this factor. Six of them were aged between 18 and 22, and the remaining three were aged between 23 and 26.

The students in this category met almost all the entrepreneurship prerequisites that prepare an individual to start a business, including as a cooperating partner and future team member (Statement 21: +3). They assumed that a suitable entrepreneurial project or accurate business direction is important for success (Statement 22: +4); also deemed important was the accumulation of a person's social capital, including interpersonal relationship, opportunities, resources, markets, etc. (Statement 6: +3). They were realistic because they paid attention to the most significant factor—money (Statement 20: +3). Similar to the students in the factor A group, they would not start a business because of employment pressure (Statement 31: −3). They believed that the opportunity is much more important than other factors, and they did not attend the entrepreneurial skills training sponsored by the government (Statement 18: −4) or participate in entrepreneurship education and training courses provided by the college (Statement 14: −3). In their eyes, age was not significant (Statement 9: −3).

4.3. Factor C (Individualistic Entrepreneur)

Factor C (see Table 3) had an eigenvalue of 2.56 and explained 9% of the study variance. Eight participants, which represented 30.8% of the P-sample with 4 males and 4 females, exemplified this factor. Six of them were aged between 18 and 22, and the remaining two were aged between 23 and 26.

The distinguishing statements of this group were different from those of the other groups because of the group's emphasis on strong personal interest (Statement 2: +4) and personal ability (Statement 8: +3). Moreover, their personal educational backgrounds (Statement 3: +3) further clarified the uniqueness of this group; therefore, they can be defined as the individualistic entrepreneur. As in the other two groups, they all thought that supporting technology is indispensable for technological entrepreneurship (Statement 16: +2). They also needed the accumulation of social capital, including interpersonal relationships, opportunities, resources, markets, etc. (Statement 6: +3).

In addition, similar to the above groups, employment pressure would not drive them to start a business (Statement 31: − 4). They assumed that they do not need part-time job experience (Statement 29: −3), and they also argued that they would not be confused by propaganda containing a large amount of entrepreneurial information (Statement 19: −3). They did not consider age to be important (Statement 9: −3), and they were confident that their self-efficacy is strong enough.

4.4. Consensus Opinions between Factors A, B, and C

Behind the different perceptions of the science and engineering students of entrepreneurial intention, there existed some consensus among these three types of students on the factors affecting entrepreneurial intention. In general, consensus statements play an important role in data analysis. These are the statements that loaded significantly for all the participants in the above three groups. Statements 6, 13, and 15 (see Table 4) did not differ between any pair formed by Factors A, B, and C. All three types acknowledged the importance of the accumulation of a person's social capital, such as interpersonal relationships, opportunities, resources, markets, etc. They also believed that they need leadership skills to spur their entrepreneurial intention. In addition, the three groups of participants did not believe that the entrepreneurial environment plays a role in college.

Table 4. Consensus statements.

Consensus statements		Factors		
No.	**Q Statements**	**A**	**B**	**C**
6 *	The accumulation of a person's social capital would affect his entrepreneurial intention, such as interpersonal relationship, opportunities, resources, markets.	+2	+3	+3
13	Leadership skills will affect the entrepreneurial intention.	+1	+2	0
15 *	The entrepreneurial environment of college spurs me to start a business.	−2	−2	−1

5. Discussion

The application of Q methodology in this study leads to a better understanding of the three diverse perspectives of the science and engineering students on entrepreneurial intention. The three defined types also reflect possible perceptions of the factors that affect one's intent to start a business, and offer a more cohesive understanding of this topic. One of Q methodology's tasks is to expose the inherent structure of a concourse [61]. In this research, however, each perception had its own specific emphasis. Although there are numerous and diverse factors that affect the decision to become an entrepreneur, the findings suggest that there are associations between the three groups identified and the different dimensions used to establish the Q samples, as discussed in the Methodology section.

To summarize, the findings indicate that the Intellectual Entrepreneur defines those who show strong positive and rational thinking toward business ventures; the Opportunity-Driven Entrepreneur defines those who react positively to an opportunity that is provided externally; and the Individualistic Entrepreneur defines those who emphasize the characteristics of personality.

The results of this study highlight distinct sets of factors that are divided by different opinions. Firstly, the findings demonstrate that Opportunity-Driven Entrepreneurs consider EI to be significantly influenced by team cooperation, projects, social capital, and economic capital. The existing literature includes similar opinions, and authors have argued that social norms affect the perception of the desirability of establishing a business venture [66]. Our results also show that Opportunity-Driven Entrepreneurs do not participate in entrepreneurship education and training courses provided by colleges. Similarly, Espíritu-Olmos and Sastre-Castillo empirically found that entrepreneurial intention may have even decreased with the increased availability of entrepreneurial courses, but they further suggest that entrepreneurship education should focus more on the students' motivations [67]. According to the findings here, the effect of entrepreneurship education on entrepreneurial intention seems to be weak; therefore, an essential question remains: How can students' entrepreneurial intention be developed by education? To address this problem, in accordance with Gibb's finding [68], it is recommended that entrepreneurship education programs foster learning environments that are characterized by "being sensitive to the demands of different contexts." For Opportunity-Driven Entrepreneurs, a well-prepared external context provides them with good conditions for acting on their entrepreneurial intention. Further research should investigate whether entrepreneurship education programs ought to focus on enhancing their ability to motivate potential entrepreneurs to engage in

entrepreneurship activity. Such programs then need to provide these students with the necessary professional entrepreneur skills and enable them to accumulate knowledge and capacity to undertake different kinds of challenges. Similarly, a diverse and complex entrepreneurial environment is necessary for entrepreneurial education to enhance entrepreneurial attitudes and abilities [69].

Secondly, from the perspective of Intellectual Entrepreneurs and Individualistic Entrepreneurs, entrepreneurial intention is significantly influenced by a strong interest and ability to start a business. This agrees with the results of Shook and Bratianus' [70] theory, which states that a more vigorous attitude toward entrepreneurship and a more favorable perception of the desirability of creating a business are required to increase entrepreneurship. For the Individualistic Entrepreneurs, their high confidence in their own skills and ability to launch their own business tends to be a significant source of their motivation to start a new venture. This is similar to the positive impact of individual self-efficacy and perceived feasibility described by the SEE model on the entrepreneur's desire toward creation of new ventures [26,28]. This implies that entrepreneurship education should focus its educational objectives on the concept of "know-how", which was put forward by Haase and Lautenschläger and refers to soft skills, such as opportunity identification and venture strategy development [71]. These skills should be especially honed for those who have a strong entrepreneurial intention.

Thirdly, there was a consensus among some of the students' perspectives, and similarities were found. The importance of accumulating personal social capital, personal leadership skills, and the entrepreneurial environment attracted the attention of all three groups. This finding is supported by the work of Mueller and Thomas, who maintained that social environment influences a person's entrepreneurial attitude and intentions more strongly than other factors [72]. Since sustainable entrepreneurship has become the mainstream in the entrepreneurial environment, both the government and colleges should focus on sustainable entrepreneurship. To this end, students could be encouraged or stimulated to transform entrepreneurial intention into action toward starting a sustainability-oriented venture. Sustainable development education aims to enable people to "not only acquire and generate knowledge, but also to reflect on further effects and the complexity of behavior and decisions in a future-oriented and global perspective of responsibility" [73]. The promotion of entrepreneurship education for a sustainable future is an interdisciplinary task. Entrepreneurs keep our economy and society vibrant by implementing new ideas, so our society needs people to possess entrepreneurship competency. Entrepreneurship education can trigger and support the process of developing such skill sets.

In addition, an opinion of Individualistic Entrepreneurs is in accordance with Minola et al.'s findings that the age of an entrepreneur has no influence on the factors of EI [74]. On the other hand, our result contradicts the findings of Strobl et al., who found that males exhibit a higher intention to become entrepreneurs [75]. In our findings, gender was not an obstacle for Intellectual Entrepreneurs. Similar to Strobl et al., Mazzarol et al. [76] stated that demographic factors, such as age, gender, and education, have a considerable impact on entrepreneurial intention and venture.

Furthermore, each factor had different variables that contributed to EI, reflecting the expansion of the convergence of entrepreneurial intention. Moreover, it was demonstrated that abundant capital will strengthen individuals' confidence in entrepreneurship. In our study, the Intellectual Entrepreneur perceives that government policy plays a role in the enhancement of entrepreneurial intentions. The results of the study also show that several obstacles, such as the lack of social capital, start-up capital, and experience hinder the process of entrepreneurship and may hamper students in colleges. Thus, educators and policymakers should prioritize their efforts to address these obstacles.

Another viewpoint highlighted by Q methodology from the three groups of science and engineering students is the new technology needed for techno-entrepreneurship. Our finding can bring awareness of the reality to the policymaker, and suggest that they design suitable strategies for on-campus techno-entrepreneurship and business ventures [77]. As previously stated, the curricula of science and engineering students emphasize the importance of technology, but they lack entrepreneurial functional knowledge, such as the business operations, marketing, accounting, and management, all of which are

also important issues in entrepreneurship education. Business-related training needs are inevitably added to entrepreneurship education programs. Only a well-implemented entrepreneurship education program will contribute to the enhancement of students' intention to become entrepreneurs.

6. Conclusions

The findings of this study have some implications for both academic studies and practice. The theoretical contribution of the paper is the identification of distinct types of science and engineering students in China with respect to their perceptions of entrepreneurial intention, as determined by applying Q methodology. These findings are in line with person X situation variables [28]. Understanding entrepreneurial intention helps researchers better understand entrepreneurial activity and how intention transforms into action. The study's characterization of these particular types also contributes to managerial practices by serving as a reference for colleges as they implement entrepreneurship education. In terms of the entrepreneurs themselves, they can gain considerable value by better understanding how perceptions and motives drive the start of a business. As a new form of entrepreneurship, sustainable entrepreneurship education can provide guidance to students in universities. For policymakers, encouraging sustainable entrepreneurship would help them solve a series of economic, social, and environmental problems. They can develop an effective entrepreneurial strategy and policy that provides both managers and educators with better instructions on how to stimulate entrepreneurial intention.

All research has limitations, and this study is no exception. Its shortcomings can be used to guide the exploratory approach in further research. Firstly, the intention of Q methodology is not to generalize research findings for a larger population. Instead, it focuses on the transformation of the context to establish the subjective viewpoints of a particular category of individuals [57]. In future studies, a more quantitative approach will be conducted using a large population to assess and generalize these research findings. Secondly, this study was conducted among science and engineering students, so the results cannot be applied to students majoring in other subjects. Thirdly, it is necessary to duplicate this Q study using other samples. Furthermore, future research could be done in other countries to determine whether inter-country or cultural differences are factors that affect entrepreneurial intention.

Finally, the process by which potential entrepreneurs become real entrepreneurs is also worth studying in depth, especially to understand the best approach to promoting the transformation of intention into real action.

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