

ORIGINAL ARTICLE

Articulating prototypical entrepreneurs in China: Implicit entrepreneurship theory

Jie Hao¹, Wen Wen², Lei Wang^{1*}, Hamish Coates²

¹School of Economics and Management, Tsinghua University, Beijing 100084, China

²Institute of Education, Tsinghua University, Beijing 100084, China

ABSTRACT

Background: China has witnessed a nation-wide upsurge of entrepreneurship and innovation over the last decade, with a particular emphasis on science, technology, engineering, and mathematics (STEM) education. The value of finding effective ways to identify aspiring talents is equally important as entrepreneurship grows. To advance the entrepreneurship education field, this paper reports on the development and validation of an instrument to measure traits revealed as important by implicit entrepreneurship theory (IET). **Methods:** As an example, the selection basis and technical requirements of the App cloud platform are given, and the development process of the sci-tech journal App based on the cloud platform is introduced in detail. **Result:** Based on the cloud platform, mobile Apps can be developed quickly without writing programs. **Conclusions:** The paper discusses a conceptual analysis of key theory, presents insights from four waves of psychometric modeling and validation, and concludes by considering contributions to STEM education, to entrepreneurial practice, and hence to broader socioeconomic development.

Key words: prototypical entrepreneurs, China, implicit entrepreneurship theory, entrepreneurship education

INTRODUCTION

Entrepreneurship is a growing facet of contemporary life, and an important driving force behind sustainable growth and development in the post-pandemic world.^[1] Having witnessed the decrease in “job for life” commitment from industries and governments^[2] and labor market disruptions following the pandemic,^[3] more people are engaging in entrepreneurial activities. In China, an average of 25,000 new enterprises were registered each day in 2021,^[4] which plays a growing socioeconomic role. Since 2012, the Ministry of Education of the People’s Republic of China has called for entrepreneurship courses to be included in the curriculum planning of all colleges and universities, including “entrepreneurship fundamental” courses for all students.^[5] In the recent report of the 20th National Congress of the Communist Party of China, the importance of innovation and entrepreneurship

education was once again emphasized: “We must adhere to the principle that science and technology are the first productive force, talent is the first resource, and innovation is the first driving force... We should thoroughly implement the innovation-driven development strategy, open up new tracks for development in new fields, and constantly shape new drivers and new advantages for development”.^[6] Along with the arms race in innovations getting fiercer in recent years, entrepreneurial education has been particularly encouraged in China’s science, technology, engineering, and mathematics (STEM) education to enable talents in STEM subjects to develop critical thinking, innovative thinking, and problem-solving skills, thus to sustain China’s leading role in research and talents cultivation in STEM.

However, student decisions to participate in entrepreneurship education programs are influenced by several factors such as entrepreneurial self-efficacy, entrepreneurial intent,

*Corresponding Author:

Lei Wang, School of Economics and Management, Tsinghua University, No.30, Shuangqing Road, Haidian District, Beijing 100084, China. Email: wanglei@sem.tsinghua.edu.cn; <https://orcid.org/0000-0001-6969-2269>

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attitude, subjective norm, goals, academic transitions, information and resources, social capital, opportunities and challenges, and past participation in entrepreneurship education programs.^[7] Researchers also pointed out that, though entrepreneurship education increases students' intention to start a business, these students' mindset is also critical.^[8,9] If they don't aware of their own opportunities to become an entrepreneur instead of being an engineer, it will be less likely for them to utilize the knowledge and skills learned from their entrepreneurial education. On the other hand, cultural elements may also influence students' choices and decision-making related to entrepreneurial activities.^[10] Taken together, there should be a cultural difference in students' thinking of whether or not they should become entrepreneurs and this kind of thinking will influence the effectiveness of entrepreneurship education.

While most of the research and theories in entrepreneurship traits and individual characteristics are developed in advanced North American or European contexts and are underpinned by psychological theories with a similar sociocultural disposition, there is a need for research from and about non-Western countries. China is a huge economy in continuing transition from a planned- to a free-market economy, embracing complex and paradoxical values such as new liberalism, Marxism, conservatism, and Confucianism.^[11] Confucian philosophy provides the core values which underpin society. Whether Confucian learning theory promotes Chinese learners to develop their entrepreneurship has always been a controversial issue. On the one hand, it is believed that those values of interpersonal relations, social (family) orientation, work attitude, and personal cultivation,^[12] Young *et al.*^[13] even proposed the concept of the "sage entrepreneur", which embodies traditional Confucian virtues such as wisdom, generosity, tenderness, firmness, and refinement. On the other hand, scholars like Jenkins,^[14] Ying,^[12] and Ward^[15] contend that certain cultures and communities are more entrepreneurial than others. Ying argues, for instance, that although some entrepreneurial attributes can be found in "traditional" Chinese culture, the most important ones, such as initiative, creativity, and innovation are either missing or in contradiction. It is important to step beyond such uncertainty given the importance and scale of entrepreneurial activity and the economy more broadly.

This paper sought to articulate and validate the prototypical characteristics of entrepreneurs in China and aimed to contribute to the field of entrepreneurship education. Through theoretical and empirical analysis, it affirms that it is feasible to define, assess and report on important characteristics of what is referred to as a "prototypical entrepreneur" in China. Working with the context of China and Asia in general, the paper makes theoretical, technical and, we hope, practical contributions to STEM education. It articulates key features of prototypical entrepreneurs in China, points out training areas for entrepreneurship

providers, and validates an assessment instrument for understanding development opportunities that are of use to educators and aspiring entrepreneurs alike. The next section explores theoretical foundations. This is followed by construct development and validation. The paper concludes by discussing its implications.

LITERATURE FOUNDATIONS

Theoretical context

"Entrepreneurship" is not a standalone idea but rather one which can be unpacked with reference to a suite of sociopsychological perspectives. Of particular relevance, implicit leadership theories (ILT) and implicit followership theories (IFT) outline individuals' personal assumptions about the traits and behaviors that characterize leaders and followers.^[16,17] In other words, leaders and followers have their own schemas that provide a set of generic assumptions and beliefs, and which shape expectations and response patterns.^[18,19] In this paper, we analyze how such concepts apply to entrepreneurship and give rise to implicit entrepreneurship theory (IET). In this paper, IET refers to individual characteristics and attributes that others implicitly expect of entrepreneurs, which exist as common shared cognitive structures that signify prototypical entrepreneurs. In other words, it captures what an entrepreneur should be in the minds of laypeople.

Implicit traits orient potential entrepreneurs towards entrepreneurship intention through perceived behavior control, and typical characteristics of entrepreneurs vary across different cultural environments. Hayton *et al.*^[20] articulate the implications of national cultures for entrepreneurship by reviewing 21 empirical studies, among which some scholars paid close attention to cross-cultural variation. Busenitz *et al.*^[21] pointed out that some individuals are more prolific in new venture creation when moved into a different cultural environment. For instance, they showed that Chinese people manifest a higher propensity to start new businesses when they migrate to new countries. This work indicates that potential entrepreneurs are more likely to be triggered by an environment that suits them. It is equally if not more important to specify the essence of those individuals' personal traits. Thomas *et al.*^[22] suggested that individual traits associated with entrepreneurship decrease systematically with the increasing cultural distance from the United States, after studying students in business, economics, and engineering across nine countries in America, and taking into account characteristics such as innovativeness, locus of control, risk-taking propensity, and energy level. Such findings might imply that these four traits are more applicable in the United States cultural environment.

Using IET, Birdthistle *et al.*^[23] studied the different cultural prototypes of successful entrepreneurs across Ireland, Guatemala, and China, and identified the following

characteristics best describe entrepreneurship in these countries: vision, creativity and innovation, willingness to explore new opportunities, and perseverance. They also proposed that cultural differences are evident in perceptions of independence and autonomy, entrepreneurial risks and challenges, locus of control, and entrepreneurial motivation. While the small sample size of 25 Master of Business Administration (MBA) students hinders the depth of analysis and generalizability, these are important ideas that gesture towards areas in need of development. IET helps to clarify different behavior patterns, and a framework of entrepreneurialism has the potential to help foster education and subsequent new venture creation.^[24,25] IET might also be seen as a form of self-concept, helping people to identify uncertain yet high-potential business opportunities.^[26] The current paper builds on this research through the study of theory and empirical analysis involving assessment scale development and validation.

Review of each dimension

Our emphasis on entrepreneurship prototypes is consistent with trait research in entrepreneurship. Embracing the most common phenomena in the literature, it covers the following fundamental dimensions: Challenging goals, proactive networking, uncertainty tolerance, and continuous passion (Figure 1). These qualities have been consistently associated with the pursuit of opportunity. Schema approaches suggest that individuals describe themselves as possessing specific characteristics, structure their beliefs and experiences in terms of these characteristics, and generally tend to behave in ways suggested by these characteristics.^[27] The following paragraphs unpack the theoretical exploration of these qualities.

Setting challenging goals is an important facet of entrepreneurial activity. Opportunity recognition involves entrepreneurs' creative work, careful investigation of and sensitivity to market needs, and as well as an ability to spot suboptimal development of resources.^[28] Thus, novel and valuable ideas that derive from creative cognition were

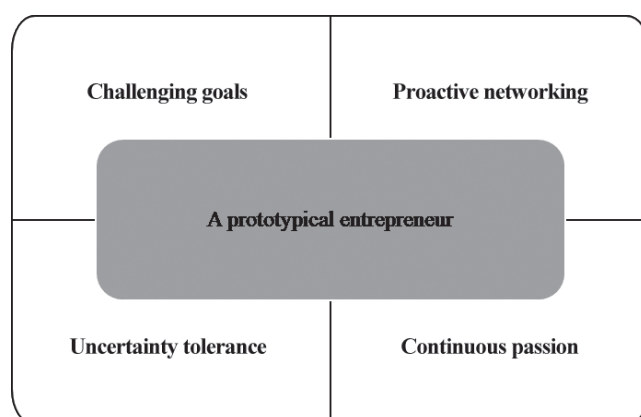


Figure 1. Implicit entrepreneurship theory construct dimensions.

described as the lifeblood of entrepreneurship.^[29] However, such creativity is associated with goal setting. Creativity in entrepreneurial tasks requires flexibly changing existing routines to explore new approaches to effectively resolve problems, while challenging goals are more likely to energize entrepreneurs to invest greater effort and develop creative approaches.^[30] According to goal setting theory,^[31] self-set challenging goals have a strong motivational influence such that individuals who set challenging goals tend to make better strategies to attain goals. Baum *et al.*^[32] surveyed 229 chief executive officers (CEOs) and found a significant positive association between goal setting and the venture growth of the company. Since the nature of entrepreneurial opportunity can be viewed as a creative product, and emerges through the continuous shaping and development of ideas,^[33] entrepreneurs' willingness and activeness in gathering different ideas and concepts are critical. It is reasonable that entrepreneurs who set challenging goals have a strong desire to creatively and continuously identify opportunities and resolve problems associated with the identified opportunities.

Proactive networking is an important part of entrepreneurial work. The social network constitutes a mechanism for entrepreneurs to create and exploit entrepreneurial opportunities through interactions and the exchange of information.^[34-36] While social interactions impact opportunity identification differently across cultures,^[37] entrepreneurs' social networks and skills usually significantly help the new venture's performance with successfully obtained information and essential resources.^[38,39] It increases the probability of entrepreneurial success by influencing knowledge structure, promoting innovation, and reducing uncertainty.^[35,40] Entrepreneurs often turn to different contacts to seek advice when uncertainty is high, and these business contacts usually not only provide external resources to the entrepreneurs, but also positively influence their internal knowledge structure, as mental templates that entrepreneurs impose on an information domain.^[40] Given that access to potential information plays an important role in opportunity exploitation, and creating and nurturing social networks is crucial in this regard,^[38] being willing to establish and join different social networks is important.^[39] Some key indicators of this facet of entrepreneurial work include the recognition that every individual may have potential networks that can be explored, a willingness to establish new social networks, being enthusiastic in social environments, a keenness to interact with different groups of people, and being happy to improve social skills.

Uncertainty tolerance constitutes a core part of most theories of the entrepreneur. The central issue of entrepreneurship is whether entrepreneurial action occurs and thus, at the individual level, it is critical to when answer entrepreneurial action occurs and who does it. McMullen *et al.*^[41] noted that entrepreneurial action

is the outcome of more willingness to bear uncertainty. This perspective is implicit in Schumpeter's theory where "he delineate[s] entrepreneurs from non-entrepreneurs not by differences in knowledge or perception but by the performance of the innovative act itself."¹⁴¹ In other words, individuals who are more tolerant of uncertainty are more likely to take action after they recognize the opportunity. Moreover, in an environment lacking certain and clear feedback during goal pursuit, entrepreneurs who set challenging goals are more likely to face obstacles as uncontested success is unlikely and it is hard to evaluate if goals are met.¹³⁰ To buffer the potential side effect of challenging goal setting, entrepreneurs also require higher levels of tolerance for uncertainty and risk. Since the pursuit of opportunity includes not only the recognition of opportunity but also the action to seize and realize the opportunity, uncertainty tolerance should be critical in most people's beliefs when they identify entrepreneurs.

Continuous passion is identified as an important facet of entrepreneurship. In a qualitative analysis, for instance, Locke¹⁴² identified passion as a core attribute of great entrepreneurs, which helps them overcome barriers, develop new products, and figure out new ways of marketing. Researchers have even suggested that passion is the most observed phenomenon of the entrepreneurial process,¹⁴³ which "can be witnessed over time in the long hours worked during venture start-up and growth phases and in the tendency for entrepreneurs to experience their venture's successes and difficulties as personal events."¹³² Passion also drives entrepreneurs to encounter extreme uncertainty and resource shortage.¹⁴⁴ Baum *et al.*¹³² surveyed 229 CEOs and found passionate CEOs had higher levels of tenacity, vision, self-efficacy, and that they set more challenging goals. Cardon *et al.*¹³⁰ proposed that entrepreneurial passion influences entrepreneurs' goal-related cognitions (*i.e.*, goal challenge, goal commitment, and goal striving) and corresponding entrepreneurial behaviors (*i.e.*, creative problem solving, persistence, and absorption), and then these two cognitive and behavior processes lead to entrepreneurial effectiveness. Entrepreneurs need to invest great effort, time, and resources as well as encounter difficulties and failures when they recognize opportunity and take actions to convert opportunity into tangible entrepreneurial success. Passion is a possible explanation for entrepreneurs' continuous sacrifice. We thus argue that as an easily observed characteristic, passion plays a critical role in distinguishing entrepreneurs and non-entrepreneurs in the implicit belief of a layperson.

METHODS AND RESULTS: CONSTRUCT DEVELOPMENT AND VALIDATION

Overview

Building on the analysis of prior research, this study developed and validated the IET instrument with a four-phased approach. The first phase is a study (Study 1)

that focused on content development and yielded a large pool of items that could be associated with the prototypical entrepreneurial characteristics. The second phase (Study 2) used exploratory factor analysis (EFA) to furnish initial insight into the emerging instrument's psychometric structure. The third phase (Study 3) validated the instrument's psychometric properties using confirmatory factor analysis (CFA), which led to and supported the process of positioning the instrument. The final phase (Study 4) is the analysis that explored the relationship between the instrument and other relevant constructs and contexts.

Study 1: Development of content

This study employed an inductive methodology to develop the initial IET item pool. Item generation began by conducting semi-structured interviews with experts in entrepreneurship. This included eight entrepreneurs and four faculty members. All eight entrepreneurs had already followed through with their business idea to some extent, including two who had achieved certain success and obtained government endorsement. Among the four faculty members in the entrepreneurship field, one was a director of an incubator who had extensive experience with evaluating and investing in start-up projects and potential entrepreneurs. The interviewers (including two of the authors) used a semi-structured interview protocol to ask questions about the interviewees' background characteristics as well as their understanding of, in China, what a typical entrepreneur is like and what capabilities such people tended to exhibit. The content derived from the interviews was examined in conjunction with a thorough review of existing research literature and in consultation with another five researchers in the field of entrepreneurship. Subsequently, the researchers identified the main similarities and differences in the interviewees' impressions of entrepreneurs, as well as behaviors that seemed particularly important to their overall assessment of the entrepreneur portrait. This yielded 120 items that described the entrepreneurs' behaviors and capabilities. For instance, an example item is "Entrepreneurs can bear high risks in work", and another is "Entrepreneurs are always passionate about what they are interested in". Two authors of the present study then reviewed the 120 items for their face and content validity, and combined items that described similar behaviors. This procedure yielded 64 items.

To test interpretability, these items were then distributed to 101 undergraduate students who were asked to carefully read each question and to evaluate whether the item statements were readable or whether some questions seemed similar or redundant.¹⁴⁵ These undergraduates were majoring in economics, finance, accounting, and management at a large university in Beijing, China. The demographics of the 101 undergraduates include 46 (45.6%) males, with an average age of 18.9 years and

standard deviation (SD) of 0.9 years, coming from 32 of 34 Chinese provinces and special regions. The items were modified and reduced according to the student feedback, distilling a final pool of 46 items.

Study 2: Exploratory factor analysis

In Study 2, we used EFA to identify the underlying structure of the initial 46 items of the IET scales. Data was collected via an online survey of 218 respondents in China, including 162 respondents with work experience and 56 undergraduate students from one large research-based university in Beijing. According to self-report, participant demographics included 116 (53.2%) males with an average age of 29.2 years (SD = 8.3 years), with 60.6% having a full-time job, 25.3% being undergraduate students, 14.2% being entrepreneurs, and having an average of 15.3 years of education (SD = 2.1 years), with most (58.3%) majoring in economics and management, followed by science (25.2%), and art and history (14.7%). Respondents with professional work experience were recruited through Sojump (www.sojump.com), who were given a link to the study pages and paid 1 USD for their participation through the system's in-built rewards mechanism. Student participants for Study 2 were recruited from a top-level university in Beijing and were informed that they could contact the researchers for the reward. Those who were interested in the study were given a link to the questionnaire. All respondents were informed about the purpose of the study and its confidentiality. The online survey included 46 IET items generated from Study 1. These were listed in random order on the questionnaire. Respondents were asked to describe the degree to which they agreed with the statements using a 10-point scale in which "1" was labeled "totally disagree" and "10" was "totally agree" (in Mandarin Chinese).

EFA was conducted using SPSS 20.0 (IBM, Chicago, USA). The suitability of the data set for EFA was established through the Bartlett's Test of Sphericity ($\chi^2 = 1269.60$, $P < 0.00$, $df = 78$) and Kaiser-Meyer-

Olkin (KMO, 0.90). Principal axis factor extraction with a varimax (orthogonal) rotation was conducted.^[46] A decision was made to extract components with eigenvalues greater than one and to attempt to explain around 50%–60% of the variance.^[47] Accordingly, an iterative process was used to eliminate items with low loadings (< 0.3) or high cross-loadings.^[48] In the end, a four-factor structure with 13 items which accounted for 70.2% of the variance was selected. After interpretation of the items with reference to existing research and earlier expert insights, the four factors were labeled "challenging goals", "proactive networking", "uncertainty tolerance" and "continuous passion". Table 1 lists the factor names, items, and the item labels used in subsequent reports.

Results in Table 2 show that all 13 factors loaded highly (> 0.50) on respective factors and the communalities for each item were also higher than 0.55. The internal consistency reliability estimates (α) for the four factors were all acceptable (> 0.70). Table 2 also gives means and SD for each item.

Study 3: Confirmatory validation

The goal of Study 3 was to evaluate the factor structure identified in Study 1 and compare the obtained model with other competing models. Responses from 217 participants were captured using the same sampling procedures as per Study 1. The achieved sample included 114 (52.5%) males with an average age of 28.0 years and SD of 8.1 years. According to self-report, 58.1% had a full-time job, 29.5% were undergraduate students, 12.0% were entrepreneurs, and one respondent reported an "other" status, with an average of 15.0 years of education (SD = 2.5 years), mostly majoring in economics and management (57.2%) followed by science (34.6%) and art and history (8.3%).

AMOS 23 was used to run a CFA of the IET instrument using maximum likelihood estimation. Table 3 shows the measurement properties of the IET instrument. All the

Table 1: Implicit entrepreneurship instrument with 4 dimensions and 13 items

Dimension	Item	Wording
Uncertainty tolerance	IET04	Entrepreneurs can manage the high risk in work well.
	IET05	Entrepreneurs are good at working under uncertainty and turbulence.
	IET06	Entrepreneurs treat what other people complain about as opportunities.
	IET15	Entrepreneurs are willing to challenge different things despite potential high risks.
Continuous passion	IET17	Entrepreneurs are always passionate about what they are interested in.
	IET18	Entrepreneurs will stay informed and focus on industries and areas of their interest.
	IET29	Entrepreneurs keep finding and integrating potential resources around them.
Proactive networking	IET14	Entrepreneurs often cultivate highly-diversified interests.
	IET31	Entrepreneurs often actively participated in clubs/activities and sought leadership positions.
	IET32	Entrepreneurs like to participate in different types of projects when they have free time.
Challenging goals	IET42	Entrepreneurs seek to make high-quality results/products.
	IET43	Entrepreneurs can act stoically when faced with their own failure.
	IET44	Entrepreneurs are never satisfied with the status quo.

IET: implicit entrepreneurship.

Table 2: Implicit entrepreneurship item descriptive and exploratory factor analysis statistics

Factor	Item	Loading	Communality	Mean	SD
Uncertainty tolerance ($\alpha = 0.77$)	IET04	0.70	0.64	7.72	1.55
	IET05	0.82	0.71	7.77	1.50
	IET06	0.63	0.58	7.79	1.39
	IET15	0.52	0.59	8.22	1.26
Continuous passion ($\alpha = 0.82$)	IET17	0.76	0.71	8.48	1.22
	IET18	0.82	0.79	8.44	1.24
	IET29	0.61	0.68	8.28	1.34
Proactive networking ($\alpha = 0.76$)	IET14	0.62	0.58	7.88	1.45
	IET31	0.84	0.79	7.72	1.67
	IET32	0.74	0.68	8.04	1.47
Challenging goals ($\alpha = 0.71$)	IET42	0.76	0.67	7.35	1.79
	IET43	0.81	0.76	7.81	1.71
	IET44	0.59	0.73	7.90	1.73

SD: standard deviations.

indicator t-values were significant ($P < 0.05$), supporting the convergent validity of each dimension. The average variance extracted (AVE) reliability for each factor is higher than 0.50, supporting the convergent validity of the scale too.

Table 4 shows that the four-factor model demonstrated a good fit with the data. This model has good psychometric statistics ($\chi^2_{78} = 155.19$, $P < 0.001$; standardized root mean square residual [SRMR] = 0.007, Tucker-Lewis Index [TLI] = 0.89, Comparative Fit Index [CFI] = 0.92, Goodness of Fit [GFI] = 0.90). By comparison, we tested a series of competing factor models. The alternative models estimated included (1) a null model, (2) a unidimensional model in which all items are loaded on a single factor, (3) a two-factor model in which the challenging goals, uncertainty tolerance, and continuous passion scales are combined, and (4) a three-factor model in which challenging goals and uncertainty tolerance scales are combined. As these were nested models, chi-square (χ^2) difference tests were used to assess which model provided a better fit to the data.^[47] The four-factor correlated model was a significantly better solution than the other models ($\Delta\chi^2$ with three-factor model = 37.03, $df = 13$, $P < 0.01$). This offers strong evidence that the four-factor model provided a better approximation to the data than the other models tested and as such should be used for the contextual examination of IETs.

Study 4: Context investigation

This section is aimed to examine the construct validity by considering the associations between the degree to which an individual thinks he or she fits with two established constructs, namely Entrepreneurial Intention and Entrepreneurial Self-efficacy. It is confirmed that the new measure was associated but different with these important entrepreneurship-relevant constructs providing evidence of discriminant validity.

In the context of entrepreneurship, self-efficacy is explained as the strength of a person's belief that he or she is capable of successfully performing the various roles and tasks of entrepreneurship.^[49] It has been found that such entrepreneurial self-efficacy fully mediates the effects of perceived learning from related courses, previous entrepreneurial experience, and risk propensity on entrepreneurial intentions.^[50] More explicitly, entrepreneurial and general self-efficacy beliefs were important predictors of entrepreneurial intention, and a key aspect of an individual being an entrepreneur.^[49,51] In line with categorization theory,^[52,53] we suggest that individuals judge the entrepreneurial qualification of another person, including themselves, based on the degree to which the target person and his or her entrepreneurship prototype is matched. If one strongly matches his or her own entrepreneurship prototype, entrepreneurial self-concept would be more accessible in the assessment and accordingly, attitudes associated with entrepreneurship perception would be influenced. Once an individual perceives oneself as a would-be "entrepreneur", he or she would have a more positive evaluation of their capability to perform the tasks of an entrepreneur, thus being more likely to take entrepreneurial actions. Therefore, we argue that the degree to which an individual thinks he or she fits his or her implicit entrepreneurship prototype will be positively associated with his or her entrepreneurial self-efficacy and entrepreneurial intention. In other words, if people think that they can tolerate uncertainty, keep a continuous passion for something, proactively take networking activities, and set challenging goals, then they are more likely to take entrepreneurial actions.

For this analysis, data were collected from 307 students who were enrolled in three major universities in Beijing. Participants were recruited by posting the questionnaire link and an introduction to the study on various social networking sites (e.g. WeChat, QQ). Participant demographics included 140 (45.6%) males with an average

Table 3: Implicit entrepreneurship measurement properties

Factor	Item	Loading
Uncertainty tolerance ($\alpha = 0.79$)	IET4	0.75
	IET5	0.68
	IET6	0.59
	IET15	0.75
Continuous passion ($\alpha = 0.81$)	IET17	0.77
	IET18	0.8
	IET29	0.74
Proactive networking ($\alpha = 0.75$)	IET14	0.56
	IET31	0.85
	IET32	0.77
Challenging goal ($\alpha = 0.73$)	IET42	0.63
	IET43	0.72
	IET44	0.73

age of 20.5 years (SD = 6.6 years), an average of 14.0 years of education (SD = 2.6 years), with 48.2% majoring in economics and management, 36.4% in science, and 22.8% in art and history.

IET was assessed with the same scale described in Study 2. However, we adapted the statements to measure the degree to which an individual thinks his or her capabilities and characteristics match the prototype of entrepreneurs. For instance, “Entrepreneurs can manage the high risk in work well.” (IET04) was adapted to “I can manage the high risk in work well”. We used the total score of the combined IET scales to represent the degree to which the respondents see themselves as having the qualities of an entrepreneur. A six-item scale from Krueger *et al.*^[54,55] was used to assess the construct of Entrepreneurial Intention. We amended the wording of the original items to reflect the self-rating process. A four-item scale from Kautonen *et al.*^[56] was used to assess Entrepreneurial Self-efficacy. We amended the wording of the original items to reflect the self-rating process. The response scale used in the aforementioned measures ranged from 1 (strongly disagree) to 5 (strongly agree). Demographic variables collected included gender,

Table 4: Confirmatory factor analysis for the competing models

Model	χ^2	df	$\Delta\chi^2$	Δdf	TLI	CFI	GFI	SRMR
Null	1243.11	59	-	-	0.00	0.00	0.33	0.38
1-factor	282.86	62	960.25	3	0.78	0.81	0.83	0.07
2-factor	238.29	64	44.57	2	0.82	0.85	0.84	0.08
3-factor	192.22	65	46.07	1	0.86	0.89	0.88	0.07
4-factor	155.19	78	37.03	13	0.89	0.92	0.90	0.07

TLI: Tucker-Lewis Index; CFI: Comparative Fit Index; GFI: Goodness of Fit; SRMR: standardized root mean square residual.

age, major field of study and the year of university study.

Table 5 shows the descriptive statistics, alpha reliabilities, and correlations. These figures indicate that it is more reliable to use the whole IET instrument with all scales combined. The correlation between IET and Entrepreneurial Self-efficacy is significant and in the anticipated direction, providing evidence of criterion validity. Given the fact that the correlation coefficient is small, the discriminant validity of IET is also supported. The correlation between IET and Entrepreneurial Intention is not significant, however, which may be explained by the poor reliability of the measure of entrepreneurial intention. This paper was not designed to report empirical results for particular groups but rather to chart the development and validation of the instrument. In conclusion to the empirical section, it is helpful in passing to flag the kinds of reports which might be developed, and Table 6 presents a small selection of mean and SD statistics.

DISCUSSION AND IMPLICATIONS

This paper reports on a study that sought to articulate and validate characteristics of potential entrepreneurs in China. Through theoretical and empirical analysis, we defined, assessed and reported on important characteristics of a prototypical entrepreneur. Research such as this carries inherent limitations, including theoretical coverage, sampling, and the lack of criterion validation. Nonetheless,

Table 5: Psychometric descriptive statistics

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10
1. Gender	0.46	0.50	-	-	-	-	-	-	-	-	-	-
2. Age	20.46	6.59	-0.18**	-	-	-	-	-	-	-	-	-
3. Education years	13.97	2.61	-0.25**	0.40	-	-	-	-	-	-	-	-
4. Entrepreneurial intention	3.95	0.94	0.05	-0.05	-0.11	0.41	-	-	-	-	-	-
5. Entrepreneurial self-efficacy	3.13	1.27	-0.18**	0.03	0.04	0.18**	0.83	-	-	-	-	-
6. Uncertainty tolerance	3.52	0.65	-0.14*	0.05	0.12*	-0.02	0.26**	0.68	-	-	-	-
7. Continuous passion	4.07	0.69	0.06	0.11	0.07	-0.08	-0.00	0.50**	0.74	-	-	-
8. Proactive networking	3.52	0.74	-0.02	0.13*	0.04	0.08	0.26**	0.49**	0.49**	0.57	-	-
9. Challenging goals	3.58	0.66	-0.13*	0.11	0.03	0.03	0.17**	0.51**	0.44**	0.29**	0.43	-
10. Implicit entrepreneurship	3.67	0.52	-0.07*	0.13*	0.08	0.01	0.23**	0.81**	0.79**	0.75**	0.72**	0.83

$n = 307$; * $P < 0.05$; ** $P < 0.01$. Cronbach's alpha reliabilities were reported in the diagonal. SD: standard deviations; 1: Gender; 2: Age; 3: Education years; 4: Entrepreneurial intention; 5: Entrepreneurial self-efficacy; 6: Uncertainty tolerance; 7: Continuous passion; 8: Proactive networking; 9: Challenging goals; 10: Implicit entrepreneurship.

Table 6: Contextual descriptive statistics

Characteristic	Group	N	Uncertainty tolerance	Continuous passion	Proactive networking	Challenging goals
Gender	Male	140	3.62 ± 0.67	4.03 ± 0.72	3.53 ± 0.77	3.67 ± 0.66
	Female	167	3.43 ± 0.63	4.11 ± 0.65	3.51 ± 0.72	3.50 ± 0.65
Age	< 22	236	3.46 ± 0.64	4.04 ± 0.69	3.48 ± 0.73	3.54 ± 0.66
	≥ 22	71	3.72 ± 0.65	4.21 ± 0.64	3.65 ± 0.75	3.73 ± 0.64
Study years	< 15	232	3.48 ± 0.66	4.05 ± 0.71	3.50 ± 0.73	3.56 ± 0.68
	≥ 16	75	3.63 ± 0.63	4.16 ± 0.61	3.56 ± 0.79	3.63 ± 0.60
Field	Science	81	3.63 ± 0.67	4.03 ± 0.71	3.49 ± 0.73	3.56 ± 0.68
	Management	148	3.52 ± 0.63	4.14 ± 0.66	3.52 ± 0.73	3.66 ± 0.65
	Humanities	70	3.36 ± 0.65	3.99 ± 0.68	3.48 ± 0.76	3.46 ± 0.62
Hometown	Developed	58	3.53 ± 0.76	3.92 ± 0.98	3.51 ± 0.82	3.58 ± 0.63
	Others	249	3.52 ± 0.63	4.11 ± 0.59	3.52 ± 0.72	3.57 ± 0.78

Data was expressed as the mean ± standard deviations (SD). Developed areas include Beijing, Shanghai, Guangdong Province.

this paper has made theoretical, technical and, we hope, practical contributions to STEM education. This is important, for the essence of being successful entrepreneurs is an expert mindset,^[57] and experts, including entrepreneurs, are definitely made, not born.^[58]

The study has explored three major issues that hold implications for future research on entrepreneurial education and entrepreneurship in general. First, there is a need to outline explicitly the key components of entrepreneur prototypes. As a result of this research, we propose the following scales: Challenging goals, proactive networking, uncertainty tolerance, and continuous passion. The second issue concerns the development of the IET instrument. In order to understand the entrepreneur, we need to look at their mental representations of career characteristics.^[59] Then in order to identify future initial takers and entrepreneurs during university study we need to help understand the mental representations that entrepreneurs tend to have, and how they believe they have such representations. The development of the IET scales provides an instrument for evaluating such mental representations. Thirdly, we identified the conceptual prototype of entrepreneurs in China. Specifically, a prototypical Chinese entrepreneur is one who can bear uncertainty, keep a continuous passion for something, proactively conduct networking activities, and set challenging goals.

An important implication of the study derives from our findings regarding the prototypes of entrepreneurs in Asia, particularly China. With a clearer and more specific set of personal traits as a guide, coordinators of entrepreneurship programs can enhance admissions processes by looking for desirable characteristics of potential entrepreneurs and can be more focused on training sessions. Against the background of rapidly increasing coverage of entrepreneurship education across the globe, many schools have limited resources, thus more targeted selection and training are important. Successfully nurturing entrepreneurs not only helps improve training programs

but also contributes to broader economic development.

Finding measurable attitudes and entrepreneurial mindsets strengthens previous research outcomes on teaching entrepreneurship.^[57,58] Such insights counterbalance prevailing underestimation of the important role that STEM education can play in developing students' entrepreneurial capability.^[60] Instead of focusing on concrete knowledge and skills in new venture creation, entrepreneurship education in STEM should give equal emphasis to non-cognitive skills, such as mindsets, attitudes, and desirability. Promoting students' non-cognitive skills requires the adoption of a student-centered teaching approach that enables students to gain real-world experience and understand the physical and emotional changes in entrepreneurial processes such as motivation, achievement, frustration, and disappointment. Therefore, universities and colleges should seek more resources to develop and simulate real entrepreneurial activities in STEM curriculum design.

Further, non-cognitive skills such as challenging goals, proactive networking, uncertainty tolerance, and continuous passion, are more a meta-capability of value innovation that can be transferred to other fields.^[61] For example, students can adopt IET to evaluate their mental attributes of learning traits and enact their learning environment. Entrepreneurship is thus not specialized to a certain group of individuals who have an interest or traits of entrepreneurship but can be expanded to all the students to improve their comprehensive capability. As people might have different mental attributes of entrepreneurship traits, adequate types and levels of entrepreneurship training that cater to unique entrepreneur prototypes bring much far-reaching influences to his or her life, and to society.

It is notable that there are other important individual characteristics that may influence students' entrepreneurial intentions and attitudes. For example, a previous study examined the determinants of entrepreneurship in 37 countries using data on individuals and regulations and

found that traits such as gender and age, along with social networks, self-assessed skills, and risk attitudes, are important factors influencing entrepreneurship.^[62] The current study focuses on implicit beliefs and calls for future research that considers the interplay of various individual characteristics. Moreover, despite not yielding significant results on the correlations between the four dimensions of IET and entrepreneurial intention, the findings indicated that two dimensions, namely uncertainty tolerance and continuous passion, showed a negative correlation with entrepreneurial intention. On the other hand, the other two dimensions, proactive networking, and challenging goals exhibited a positive correlation with entrepreneurial intention. This suggests that future research could potentially explore and utilize IETs at a dimensional level.

CONCLUSION

China has witnessed a nation-wide upsurge of entrepreneurship and innovation, with strong appeal and support from the central government. However, this does not mean that entrepreneurial intentions and capability will occur and be developed automatically, especially when the Confucian heritage of learning and scholarship is towards moral self-cultivation and cherishes personal qualities such as modesty, harmony, and moderateness, which may appear to contrast with the qualities of entrepreneurship. Promoting entrepreneurship in STEM requires a systematic and integrative top-level design of the educational goals, curriculum, assessment, and evaluation at the institutional and national levels. It is important for educators to play an active role in promoting entrepreneurship among STEM students. This can be achieved by implementing interventions in the classroom to reduce the discrepancy between students' implicit entrepreneurial theory and their self-image. By encouraging students to view their entrepreneurial potential as malleable, educators can help them become aware of their capabilities as entrepreneurs. Additionally, policymakers and practitioners must prioritize self-awareness and inclusiveness in their efforts to support entrepreneurship among STEM students. Institutions can create an entrepreneurial identity-safe environment by taking affirmative steps to challenge bias and stereotypes surrounding entrepreneurs. By fostering a culture that encourages open discussion and critical reflection on these issues, both students and teachers can be empowered to pursue entrepreneurship with confidence and enthusiasm.

DECLARATIONS

Author contributions

Hao J: Conceptualization, Data curation, Writing—Original draft, Writing—Review and Editing. Wen W: Conceptualization, Validation, Writing—Review

and Editing, Investigation, Resources. Wang L: Conceptualization, Data curation, Methodology, Formal analysis, Writing—Original draft, Writing—Review and Editing. Coates H: Conceptualization, Supervision.

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