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Impacts of innovativeness and attitude on entrepreneurial intention: among engineering and non-engineering students

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Abstract This study attempted to explore the impacts of attitudinal antecedents on students' entrepreneurial intention. Comparisons between students of engineering and non-engineering backgrounds and gender groups were made. Total of 998 students from universities in Hong Kong were surveyed, leading to a number of highlights in the study. First, it is found that the learning motivation strongly correlates with innovativeness, which in return affects the entrepreneurship intention. Second, the educational measures designed for senior year students would be slightly different from those for junior year students, whilst the junior year students may need more facilitation to motivate their learning. Thirdly, the 'innovativeness' of engineering students is found significantly and strongly correlated to 'self-efficacy' and significantly to 'attitude'. The 'attitude' of engineering students is found more significantly contributing to their 'entrepreneurial intention'. The interesting results show that for engineering students, though perceiving higher levels of innovativeness, 'attitudes' and 'entrepreneurial intention', the critical attributes in determining 'entrepreneurial intention' are 'attitudes' and 'self-efficacy'. Fourthly, attitudes seem a lot more influencing to the entrepreneurial intention among female students, whilst 'innovation' is the a lot more influencing among male students. There are some limitations in this study, such as the sample size and survey design. In order to secure a high level of content validity, some items of the constructs are excluded possibly due to the sample size and the uneven numbers of the different sample groups. Future study is recommended to include students from different countries in order to have more representative results, and the research model could be further extended to explore the effects of other demographic parameters.

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Introduction

The growing viability of entrepreneurship has promoted individual career options in entrepreneurship. Entrepreneurship has been playing a more and more important role in economic development (Verheul et al. 2006; O'Connor 2013), contributing to job creation and social wealth (Langowitz and Minniti 2007). In fact, entrepreneurship is one of the fastest growing subjects in undergraduate education overall (Brooks et al. 2007). Furthermore, there is substantial and growing student demand for entrepreneurship education. In USA, 41 % of college freshmen considered entrepreneurship education is "essential" or "very important" (Pryor et al. 2014). More specifically, according to an ASEE survey, about 50 % of faculty members and educators considered entrepreneurship programs are important for their engineering undergraduates (Peterfreund 2013).

Many scholars agreed that education and training on entrepreneurship are crucial to fostering the entrepreneurial intentions that predict entrepreneurial behavior (Dutta et al. 2010; Dickson et al. 2008; Linan et al. 2011; Souitaris et al. 2007). The importance of entrepreneurship education has been emphasized in both business and engineering schools (Bygrave and Zacharakis 2008; Hisrich et al. 2008).

It is agreed that engineers need to be entrepreneurial in order to understand and contribute in the context of the market (Byers et al. 2013; Pekkinen et al. 2015). Universities are increasingly including entrepreneurship in engineering education in recent decades (Da Silva et al. 2015)

Entrepreneurship education teaches engineering students in all disciplines the knowledge, tools, and attitudes that are required to identify opportunities and bring them to life. It gives engineering students solid experience in product design and development, prototyping, technology trends, and market analysis (Nelson and Byers 2010). Managing innovation, integrating technological, market, and organizational change have been studied (Tidd and Bessant 2009). And furthermore, design for manufacture and assembly and concurrent engineering concepts have been addressed in technology ventures and engineering entrepreneurship education (Anderson 2008; Mäkimurto-Koivumaa and Belt 2015). In this sense, integration of entrepreneurship into the required engineering curriculum has predominantly focused on senior capstone design courses (Da Silva et al. 2015).

To meet the challenges due to advances in technology in developing nations, such as India and China, entrepreneurship programs in engineering education are highly encouraged and being developed to promote entrepreneurial mindsets among all graduating engineers (Radharamanan and Juang 2012).

It is noted that the perceptions of engineering and non-engineering students about entrepreneurship are different (Gupta et al. 2005), so the influence of entrepreneurship education on their entrepreneurial attitudes and intentions would be different. This paper, with reference to the theory of planned behavior, which has been recognized appropriate to explain entrepreneurial intention (Ajzen 1991, 2005; Souitaris et al. 2007), addresses this gap by studying the associations of entrepreneurship education and innovativeness as well as the attitudes of students with engineering or non-engineering backgrounds.

The research questions posed in this paper are: (1) Does engineering education influence the entrepreneurial intentions of students? (2) What are the exact differences between engineering and non-engineering students in entrepreneurial intentions? The result will contribute to developing appropriate education measures to facilitate students in achieving their entrepreneurial potential in the context of engineering education.

Theoretical background

Entrepreneurial intention and education

Entrepreneurship education influences entrepreneurial intentions to engage in entrepreneurship (Dickson et al. 2008; Dutta et al. 2010; Sanchez 2011). Despite the popularity of entrepreneurship education, is generally accepted that well structured entrepreneurship programs are still lacking (Matlay 2005; Maritz and Brown 2013). Some researchers have concentrated on the theoretical content of entrepreneurship courses/programs (Fiet 2001), while others emphasized the adoption of a more practically focused and active-based approach (Mbaziira and Oyedokun 2007; Dermol and Cater 2013).

Research on entrepreneurship education appears somehow immature and it is challenging for educators to develop quality entrepreneurship courses/programs by designing appropriate education strategies (Matlay 2005; Novak et al. 2016). Addressing the differences between engineering and non-engineering students regarding their entrepreneurial attitudes and intentions will help to clarify the needs and factors influencing the startup intentions of specific groups with various backgrounds. Many factors influence the emergence of entrepreneurial activities, such as economic environment and personality (Arenius and Minniti 2005), whilst individual intention to start up new business plays a decisive role (Ajzen 2005; Krueger et al. 2000). Entrepreneurship education intervention seems to have a critical position in enhancing entrepreneurial intention (Fayolle et al. 2006; Souitaris et al. 2007; Dutta et al. 2010; Lo et al. 2012).

Attitude and entrepreneurial intention

Many empirical studies on entrepreneurship have tested TPB and is proven that this model is appropriate in studying entrepreneurial intention (Fayolle et al. 2006; Souitaris et al. 2007; van Gelderen et al. 2008). Intention is the key to explaining human behavior (Sheeran 2002). Many social behaviors, such as entrepreneurship can be best predicted by intentions (Ajzen 1991, 2005; Babnik and TrunkSirca 2014). In TPB, three attitudinal antecedents determine intention and, in turn, the intention influences behavior. The first antecedent, attitude toward behavior, refers to personal interest in and desirability for particular behavior. The second one, a subjective norm, is the social pressure perceived by the person to undertake or not to undertake the behavior. The third one, perceived behavioral control, refers to the ease or difficulty in undertaking the behavior and it is highly related to the concept of self-efficacy or self-capability. Meta-analytical evidence has shown that TPB is robust (Armitage and Conner 2001). Entrepreneurial attitudes at both the personal level and social level elucidate how the entrepreneurial intention forms. These attitudes and intentions are associated with individual perception and they are learnable (Ajzen 2005), thus, fostering these variables is crucial to promoting entrepreneurship.

Conceptual models and hypotheses

Figure 1 presents the initial model. The model demonstrates the possible influence of engineering education on students' entrepreneurial intention as well as its four attitudinal antecedents: learning motivation, innovativeness, attitude toward entrepreneurship and efficacy and were measured. Among the four antecedents, attitude and efficacy are evolved from the TBP (as stated in "Attitude and entrepreneurial intention"), which are considered as affecting entrepreneurship intention.

Three hypotheses are formulated. The first hypothesis is to confirm if the behavior explains the entrepreneurial intentions of students in the context of this study. Many empirical studies showed the relationship between the attitudes and entrepreneurial intentions (van Gelderen et al. 2008; Gird and Bagraim 2008; Luthje and Franke 2003; Lo et al. 2012). It is equally important as the innovativeness towards entrepreneurial intention.

H1: 'Attitude' toward entrepreneurship and 'self-efficacy' of individual students positively relates to 'entrepreneurial intention':

H1a: Attitude positively relates to entrepreneurial intention
H1b: Self-efficacy positively relates to entrepreneurial intention

The second hypothesis deals with the relationship between innovativeness and entrepreneurship intention. It is thus hypothesized the intention is correlated to the innovativeness of students.

H2: 'Innovativeness' of individual students positively relates to entrepreneurial intention

The third hypothesis is to verify if there exist differences between engineering students and non-engineering students with reference to the level of innovativeness.

H3: 'Innovativeness' is different between engineering students and non-engineering students

Finally, the fourth hypothesis is to verify if there exist differences between male and female students with reference to the level of innovativeness.

H4: 'Innovativeness' is different between male and female students

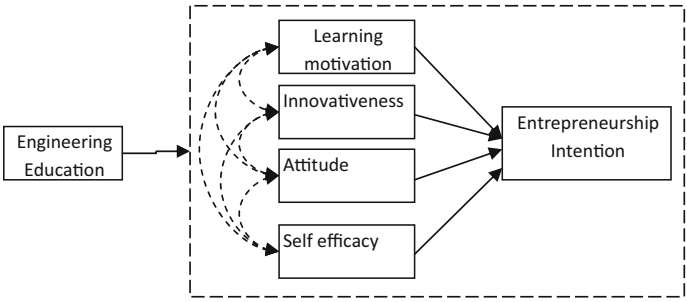

Fig. 1 Proposed initial model

Methodology

Data collection

Questionnaires were administered to 400 engineering students who took an entrepreneurship course in their classes and randomly to 800 non-engineering students (Business and Science backgrounds). A total 998 of valid questionnaires were collected including 251 (25.2 %) from the engineering group and 747 (74.8 %) from the non-engineering group.

The average age of all the respondents was 22 years old, and most of them (>96 %) were in their second or third year of study. These figures roughly corresponded to the general characteristics of engineering students in universities in Hong Kong (University Grants Committee 2010). Among the 998 student surveyed, 58.3 % (582) were male students and 41.7 % (416) were female.

Survey design

Four behavioral variables (learning motivation, entrepreneurial intention, attitude toward entrepreneurship and efficacy) were measured. 7-point Likert scale was used with 1 representing strongly disagree to 7 representing strongly agree.

Entrepreneurial intention was measured by four items developed based on Autio et al. (2001), Kolvereid (1996) and, Kolvereid and Isaksen (2006).

The measures of *attitude toward entrepreneurship* were developed based on the items validated by Luthje and Franke (2003) and, Kolvereid and Isaksen (2006). Three items were used for measuring this variable.

The measures of *self-efficacy* were developed based on the items used by Autio et al. (2001) and Kolvereid and Isaksen (2006). Three items were used: (1) If I start my own business, the chances of success would be very high, (2) I have enough knowledge and skills to start a business, and (3) I am capable to develop or handle an entrepreneurial project, there were five items added to this variable.

Learning motivation was measured based on five items: (1) desire to learn, (2) desire to learn new things, (3) I enjoy studying the subjects taken, (4) I enjoy in attending classes relevant to interesting topics and (5) putting effort into study for rewards.

The *innovativeness* was measured by seven items: (1) seeking new ways of viewing things, (2) like to experiment various ways of doing things, (3) like to surprise people with novel ideas, (4) hope to develop new techniques in my field of work, (5) participate in creative activities, (6) original ideas always occur to me, (7) prefer to work with original thinking.

Hypothesis testing methods

A specific method of structural equation modeling (SEM), called the partial least squares (PLS) approach to SEM, was applied in this study to test the proposed model. The PLS approach has an advantage over other types of SEM, in that it involves no assumptions about the population or scale measurement (Fornell and Bookstein 1982). In general PLS can be described as a family of alternating least squares algorithms, which extend principal component and canonical correlation analysis (Henseler and Sarstedt 2013). It consists of two sets of equations, referred as an inner model and an outer model. The first defines

relations between unobserved or latent variables. The outer model defines the relations between a latent variable and its observed indicators (manifest variables).

The deficiency of lacking an index that could provide the researcher with a global validation of the model has long been considered as a major drawback of PLS. However, Tenenhaus et al. (2004) proposed a global criterion called the goodness-of-fit index (GoF) to validate a PLS path model globally. As reported in Henseler and Sarstedt (2013), GoF takes both the measurement and structural models' performance into account.

The PLS method in this study was applied using the plspm package (Sanchez and Trinciguera 2013) in statistical programme R (R Core Team 2014).

Reliability and validity tests

Preliminary tests, included checking the unidimensionality of all five blocks of constructs (Attitude, Self-Efficacy, Learning Motivation, Innovativeness and Entrepreneurial intention) and the results contained in outer model, were performed.

Acceptable values for loadings are values greater than $\sqrt{2}/2$. Equivalently, communalities which represent the amount of variability explained by a latent variable should be

Table 1 Demographic details of respondents

	Type of bachelor degree		
	Business (BBA)	Sciences (BSc)	Engineering (BEng)
Gender			
Male	288 (57.8)	149 (59.4)	145 (58.2)
Female	210 (42.2)	102 (40.6)	104 (41.8)
Age			
<20	84 (16.9)	43 (17.1)	42 (16.9)
20–22	373 (74.9)	177 (70.5)	178 (71.5)
23–25	41 (08.2)	31 (12.4)	29 (11.6)
Expected year of graduation (years left before graduation)			
2013 (1)	106 (21.3)	110 (43.8)	102 (41.0)
2014 (2)	392 (78.7)	130 (51.8)	139 (55.8)
2015 (3)	0 (00.0)	11 (04.4)	8 (03.2)
Expected monthly income after 5 years			
<$10,000	107 (21.5)	84 (33.5)	82 (32.9)
$10,000–$29,999	358 (71.9)	157 (62.5)	156 (62.7)
$30,000–$49,999	33 (06.6)	10 (04.0)	11 (04.4)
Entrepreneurship role model in family			
Yes with positive feedback	107 (21.5)	116 (46.2)	108 (43.4)
Yes with negative feedback	66 (13.3)	15 (06.0)	19 (07.6)
No	325 (65.3)	120 (47.8)	122 (49.0)
Entrepreneurship role model in friends			
Yes with positive feedback	238 (47.8)	119 (47.4)	109 (43.8)
Yes with negative feedback	49 (09.8)	22 (08.8)	22 (08.8)
No	211 (42.4)	110 (43.8)	118 (47.4)

greater than 0.5 (Sanchez 2013). After applying the PLS method, some variables did not satisfy the loading and communalities conditions and were therefore removed from the initial model. These excluded variables were: E4 and E7, Lm3 and Lm5, Ino1, Ino2, Ino4, Ino6 and Int4 (Tables 1, 2).

After excluding the unsuitable manifest variables, the unidimensionality for each of five constructs was checked again applying Cronbach's alpha and Dillon-Goldstein's rho. The reliability and validity results presented in Table 3 indicate internal consistency (all Cronbach's alpha and Dillon-Goldstein's rho-values are higher than $\sqrt{2}/2$). The results indicates that the items respectively converged into their belonging factors with loadings that exceeded 0.5. Regarding the eigen-analysis, the first eigenvalue is much larger than 1, while the second eigenvalue is smaller than 1. Thus, the construct validity of the measurements used in this paper is achieved (Hair et al. 2006).

Five constructs were further evaluated by way of considering the outer model estimation results, including outer weights, loadings and communality measures (Table 4). For each block of the model, the quality of the measurement was assessed by applying the

Table 2 List of items in the survey

Label	Initial items
A1	I'd rather be my own boss than have a secure job
A2	I can make big money only if I am self-employed
A3	I'd rather found a new company than be the manager of an existing one
E1	If I wanted to, creating a new business would be easy
E2	If I start my own business, I would have complete control over the situation
E3	If I start my own business, the chances of success would be very high
E4	If I create my own business, I would be ready for being overworked
E5	I have enough knowledge to start a business
E6	I believe in myself in developing an entrepreneurial project
E7	Starting up a firm of my own would be the best way for me to take full advantage of my education
Int1	I will join on-campus entrepreneurial programs if available
Int2	I will start my own business after graduation in the future
Int3	I will work together with partners to start a new business in the future
Int4	I will start my own business if financial support is secured
Lm1	I frequently desire to learn something of great significance
Lm2	I often desire to be successful in learning something new
Lm3	People have told me that I seem to enjoy studying in the subjects taking
Lm4	I enjoy attending classes relevant to the knowledge I am interested in
Lm5	If the possible award was very high, I would not be hesitating putting my efforts in the study
Ino1	I am always seeking new ways to look at things
Ino2	I like to experiment with various ways of doing the same thing
Ino3	I often surprise people with my novel ideas
Ino4	I hope to develop new techniques in my field of work
Ino5	People often ask me for help in creative activities
Ino6	Original ideas have occurred to me at almost any time of the day
Ino7	I prefer work that requires original thinking

Table 3 Unidimensionality of blocks

Latent variable	MVs	Cronbach's alpha	Dillon-Goldstein's rho	Eig. 1st	Eig. 2nd
Attitude	3	0.841	0.904	2.28	0.462
Efficacy	5	0.723	0.845	1.94	0.662
Learning motivation	3	0.769	0.867	2.05	0.549
Innovativeness	3	0.906	0.930	3.64	0.537
Entrepreneurial intention	3	0.794	0.879	2.12	0.501

Table 4 The outer model estimation

Latent variable	Manifest variable	Outer weight	Loadings	Communality
Attitude	A1	0.401	0.749	0.560
	A2	0.438	0.809	0.654
	A3	0.407	0.849	0.721
Efficacy	E1	0.194	0.823	0.676
	E2	0.283	0.810	0.656
	E3	0.264	0.928	0.861
	E5	0.191	0.845	0.715
	E6	0.241	0.848	0.719
LearnMotivation	Lm1	0.340	0.866	0.750
	Lm2	0.497	0.935	0.874
	Lm4	0.300	0.804	0.646
Innovativeness	Inno3	0.430	0.836	0.699
	Inno5	0.442	0.872	0.761
	Inno7	0.332	0.768	0.590
EntreIntention	Int1	0.355	0.803	0.654
	Int2	0.443	0.883	0.779
	Int3	0.387	0.836	0.700

communality index, which measures how much the manifest variability in the individual block is explained by its own latent variable's scores (Esposito Vinzi et al. 2010). In this study, there was more valid variance than error in its measurement as all communality scores were higher than 50 %.

The set of information provided in Table 5 examines how each item relates to each construct. According to Chin (2010), not only should each measure be strongly connected to the construct it attempts to reflect, but it should not have a stronger connection with another construct. The latter would imply the discriminant validity problem, i.e. the measure in question is unable to discriminate as to whether it belongs to the construct it was intended to measure or another one. In Table 5, we can observe that each item loads significantly more on its own construct than on other constructs. Consequently, all constructs share more variance with their measures compared to other constructs. The discriminant validity is thus supported.

Table 5 Loadings and cross-loadings for the measurement (outer) model

	Attitude	Efficacy	LearnMotivation	Innovativeness	EntreIntention
A1	**0.749**	0.482	−0.164	0.354	0.462
A2	**0.809**	0.507	0.099	0.318	0.505
A3	**0.849**	0.606	−0.136	0.095	0.470
E1	0.505	**0.823**	−0.179	0.228	0.417
E2	0.499	**0.810**	0.130	0.446	0.608
E3	0.615	**0.928**	−0.005	0.318	0.567
E5	0.582	**0.845**	−0.062	0.361	0.411
E6	0.616	**0.848**	0.103	0.519	0.519
Lm1	−0.106	0.016	**0.866**	0.262	0.086
Lm2	−0.025	0.125	**0.935**	0.386	0.126
Lm4	−0.099	−0.174	**0.804**	0.163	0.076
Inno3	0.104	0.288	0.442	**0.836**	0.409
Inno5	0.444	0.388	0.256	**0.872**	0.421
Inno7	0.239	0.462	0.081	**0.768**	0.317
Int1	0.353	0.370	0.146	0.474	**0.803**
Int2	0.580	0.642	0.047	0.407	**0.883**
Int3	0.557	0.493	0.109	0.306	**0.836**

Items of high significance are bolded

Results

Entrepreneurship intention and other factors

The mean scores obtained from females are in general lower than from males, except entrepreneurship intention (shown in Table 6). It is quite interesting that female students perceived themselves are of being significantly at the lower degree of 'attitude', 'learning motivation', 'innovativeness' and 'self-efficacy', but having a higher level of 'entrepreneurship intention'. This maybe a bit surprising, but at the same time, it may also imply that females' intention of being entrepreneurs are not that strongly associated with those factors, as for males.

The results in Table 7 show that more mature students perceived themselves as being more motivated in learning, higher levels of innovativeness and higher levels of entrepreneurship intention. Whilst the student juniors are of higher levels in attitude of doing business and efficacy. The result is quite interesting as these variables are sensitive to age, and it is found the students at the age groups in-between do not have strong inclinations. The results may imply that younger students have stronger intrinsic values (i.e. attitudes, efficacy), and as they become more mature, they are motivated to learn and become more innovative, and thus have a stronger sense of entrepreneurship.

Engineering students are found to have significantly higher levels of 'attitude', 'learning motivation', 'self-efficacy' and 'entrepreneurship intention', when compared to non-engineering students (Table 8).

By comparing the results among students in different years, it is found that senior students have significantly higher innovativeness and entrepreneurship intention (Table 9).

Table 6 Relationship between gender and entrepreneurship intention by disciplines

Variable (codes)	Mean		
	Male	Female	Sig.
Engineering			
Attitudes (A1, A2, A3)	4.47	4.57	No
LearnMotivation (Lm1, Lm2, Lm4)	5.09	4.15	Yes
Innovativeness (Ino3, Ino5, Ino7)	4.80	3.97	Yes
Efficacy (E1, E2, E3, E5, E6)	4.03	3.98	No
EntreIntention (Int1, Int2, Int3)	4.45	4.64	No
Business			
Attitudes (A1, A2, A3)	3.54	3.25	Yes
LearnMotivation (Lm1, Lm2, Lm4)	4.79	4.68	No
Innovativeness (Ino3, Ino5, Ino7)	3.88	3.91	No
Efficacy (E1, E2, E3, E5, E6)	2.95	2.69	Yes
EntreIntention (Int1, Int2, Int3)	3.15	3.37	Yes
Science			
Attitudes (A1, A2, A3)	4.36	4.44	No
LearnMotivation (Lm1, Lm2, Lm4)	5.02	4.22	Yes
Innovativeness (Ino3, Ino5, Ino7)	4.71	3.96	Yes
Efficacy (E1, E2, E3, E5, E6)	3.90	3.76	No
EntreIntention (Int1, Int2, Int3)	4.27	4.43	No

In the Table 7, older students are found to have significantly higher levels of learning motivation and innovativeness as well.

PLS modeling results

PLS modeling was carried out, and the results of the PLS approach are shown in Fig. 2. All path coefficients between latent variables in the model are positive, which indicates an increase (decrease) in the value of an independent latent variable will also increase (decrease) the value of the related dependent latent variable.

To obtain information about the variability of the parameter estimates, re-sampling procedures were used. More specifically, a bootstrap method was applied to estimate the significance of the path coefficients, in each of the 200 re-samples. The bootstrap method is recommended for estimating the significance of path coefficients (Lohmöller 1989). The bootstrap confidence interval (95 %) is provided by the percentiles 0.025 and 0.975 for each of displayed results (as shown in Table 10). Since no bootstrap interval for the path coefficients in Table 10 contain zero, it can be concluded that these coefficients are significant at the 5 % confidence level.

The quality of each structural equation in the model is measured with an evaluation of the r-square fit index. In this study (as shown in Table 10), the factors explain almost 70 % of the variance of the perceived Entrepreneurial intention. As a rule of thumb, a GoF(Goodness of Fit Index) value equal to or higher than 0.70 speaks in favor of the model (Tenenhaus et al. 2004; Sanchez 2013). In this study, the value of GoF index is found to be 0.745, thus confirming satisfactory model performance.

Table 7 Relationship between age group and entrepreneurial intention by disciplines

Variable (codes)	Mean			Sig.
	<20 (Group A)	20–22 (Group B)	23–25 (Group C)	
Engineering				
Attitudes (A1, A2, A3)	5.32	4.39	4.02	Yes
LearnMotivation (Lm1, Lm2, Lm4)	3.85	4.90	4.81	Yes
Innovativeness (Ino3, Ino5, Ino7)	3.68	4.46	5.57	Yes
Efficacy (E1, E2, E3, E5, E6)	4.05	4.13	3.28	Yes
EntreIntention (Int1, Int2, Int3)	4.49	4.45	5.00	Yes
Business				
Attitudes (A1, A2, A3)	3.88	3.28	3.72	Yes
LearnMotivation (Lm1, Lm2, Lm4)	4.36	4.80	4.98	Yes
Innovativeness (Ino3, Ino5, Ino7)	3.61	3.85	4.77	Yes
Efficacy (E1, E2, E3, E5, E6)	2.95	2.78	3.15	Yes
EntreIntention (Int1, Int2, Int3)	3.48	3.14	3.70	Yes
Science				
Attitudes (A1, A2, A3)	5.17	4.28	4.00	Yes
LearnMotivation (Lm1, Lm2, Lm4)	4.37	4.80	4.98	Yes
Innovativeness (Ino3, Ino5, Ino7)	3.64	4.39	5.51	Yes
Efficacy (E1, E2, E3, E5, E6)	3.93	3.91	3.27	Yes
EntreIntention (Int1, Int2, Int3)	4.40	4.23	4.92	Yes

Correlations among the variables

Before testing the hypotheses, the correlation among the variables was analyzed, as shown in Table 11. Attitude toward entrepreneurship, innovativeness and self-efficacy are all significantly related to entrepreneurial intention ($p < 0.01$). Learning motivation was significantly but weakly related to entrepreneurial intention ($p < 0.05$) ($r = 0.12$), while only significantly correlate to 'innovativeness'. The correlations may indicate that it is needed to further explore how the entrepreneurial intention is influenced by three attitudinal factors (attitude toward entrepreneurship, innovativeness and self-efficacy), and how the learning motivation can affect the entrepreneurship intention indirectly.

Group comparisons

Group comparisons were made among major discipline groups ("The effect of disciplines") and gender groups ("Gender effect"). It is to justify the effects of major disciplines and effect of gender.

The effect of disciplines

The results are compared between different groups, and students from different disciplines (engineering versus business and science). The research model was examined across

Table 8 Relationship between study major and entrepreneurship intention

Variable (codes)	Mean			Sig.
	Engineering (Group A)	Business (Group B)	Science (Group C)	
Attitudes	4.51	3.42	4.39	Yes
LearnMotivation	4.71	4.74	4.69	No
Innovativeness	4.47	3.89	4.40	Yes
Efficacy	4.01	2.84	3.84	Yes
EntreIntention	4.53	3.24	4.34	Yes

Table 9 Relationship between the year of graduation and entrepreneurial intention

Variable (codes)	Year of graduation			Sig.
	2013 (Group A)	2014 (Group B)	2015 (Group C)	
Attitudes	3.95	3.90	5.00	Yes
LearnMotivation	4.70	4.73	5.00	Yes
Innovativeness	4.37	4.06	4.33	Yes
Efficacy	3.72	3.17	5.20	Yes
EntreIntention	4.32	3.60	4.00	Yes

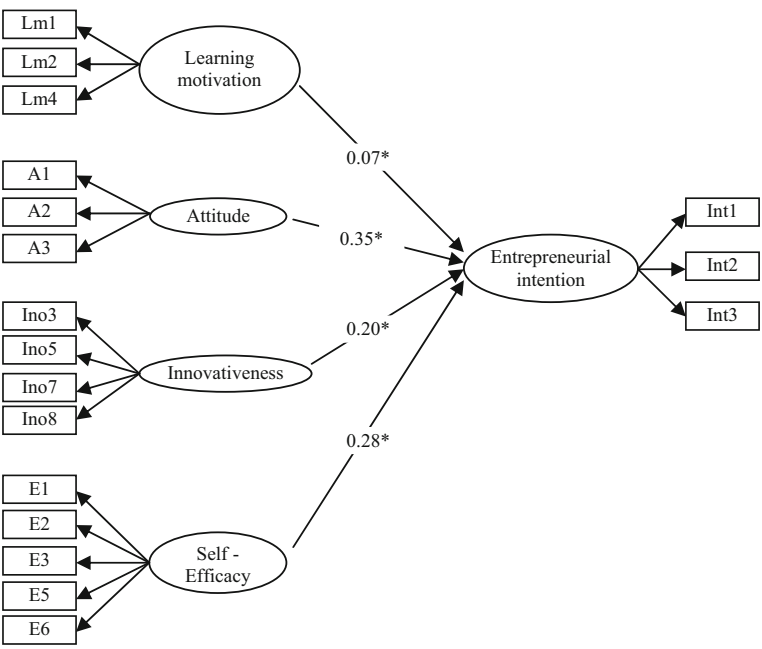

Fig. 2 Final model

Table 10 The outer model estimation

Latent variable	Original	Mean. Boot	Std. Error	Perc. 0.025	Perc. 0.975
LearnMotiv → EnterInt	0.072	0.068	0.032	0.000635	0.119
Attitu → EnterInt	0.353	0.350	0.033	0.284296	0.416
Innova → EnterInt	0.203	0.207	0.029	0.153542	0.257
Selfeff → EnterInt	0.281	0.280	0.035	0.200397	0.344

Table 11 Correlations among the variables

	LearnMot	Attitu	Innova	Seff	EnterInt
Learning Motivation (LearnMot)	1	−0.08*	0.33**	0.01	0.12*
Attitude toward entrepreneurship (Attitu)	−0.08*	1	0.32**	0.66**	0.60**
Innovativeness (Innova)	0.33**	0.32**	1	0.45**	0.47**
Self-efficacy (Seff)	0.01	0.66**	0.45**	1	0.61**
Entrepreneurial intention (EnterInt)	0.12*	0.60**	0.47**	0.61**	1

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

engineering students and students from other disciplines (business and science). The results are presented in Tables 12, 13 and Fig. 3.

From the models (Fig. 3) of the two groups (students from the engineering discipline and non-engineering disciplines), it was found that attitude and self-efficacy were the significant factors contributing to the entrepreneurial intention of engineering students (0.36** and 0.29** respectively) while innovativeness, attitude and self-efficacy were all significant among non-engineering students (0.36**, 0.22** and 0.27**). It is interesting to note the difference in the significance of innovativeness towards entrepreneurial intention between engineering and non-engineering students, where the mean score of 'innovativeness' of engineering students is significantly higher than of non-engineering students (4.47 and 4.06), as in Table 8.

Gender effect

Similarly, differences in the model between male and female students are also tested. Results are presented in Table 14 and Fig. 4.

It is found two significant differences in the 'impacts' of four behavioral variables towards entrepreneurial intention between Male and Female model, they are in the impact of 'attitude' and 'innovation' (p value < 0.05). However, the differences in the impact of learning motivation (p value $= 0.078$) and self-efficacy (p value $= 0.463$) were not statistically significant.

Discussion

Having said that entrepreneurship is one of the faster growing subjects in undergraduate education overall (Brooks et al. 2007), entrepreneurship education is no longer confined to business schools. It gives engineering students solid experience in product design and

Table 12 Engineering and business groups

Latent variable	Global	Eng	Buss	Abs. diff.	*p* value	Sig. 05
LearnMot → EnterInt	0.072	0.139	−0.162	0.294	0.000	Yes
Attitu → EnterInt	0.353	0.357	0.220	0.137	0.029	Yes
Innova → EnterInt	0.203	0.176	0.353	0.177	0.033	Yes
Selfeff → EnterInt	0.281	0.289	0.272	0.017	0.416	No

Table 13 Engineering and science groups

Latent variable	Global	Eng	Science	Abs. diff.	*p* value	Sig. 05
LearnMot → EnterInt	0.072	0.139	−0.068	0.207	0.000	Yes
Attitu → EnterInt	0.353	0.357	0.257	0.100	0.042	Yes
Innova → EnterInt	0.203	0.176	0.249	0.181	0.073	No
Selfeff → EnterInt	0.281	0.289	0.303	0.014	0.202	No

Fig. 3 Path analysis models for engineering, business and science students

Table 14 Male and Female groups

Latent variable	Global	Male	Female	Abs. diff.	*p* value	Sig. 05
LearnMot → EnterInt	0.072	0.117	0.211	0.094	0.078	No
Attitu → EnterInt	0.353	0.011	0.515	0.504	0.000	Yes
Innova → EnterInt	0.203	0.446	−0.111	0.557	0.000	Yes
Selfeff → EnterInt	0.281	0.344	0.327	0.017	0.463	No

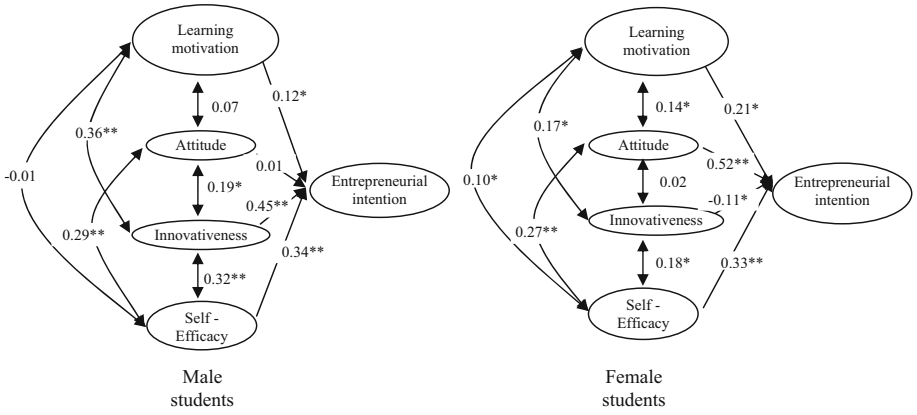

Fig. 4 Path analysis models for male and female students

development, prototyping, technology trends, and market analysis (Nelson and Byers 2010). This "Discussion" section thus attempts to answer the questions posed in the beginning: "(1) Does engineering education influence entrepreneurial intentions of students? (2) What are the exact differences between engineering and non-engineering students in entrepreneurial intentions?" by referring to the results obtained from the study.

Implications of offering entrepreneurship courses to engineering students

This study has important implications of offering entrepreneurship courses to engineering students. In order for courses to be constructive and facilitate the entrepreneurial potential of students, the courses should consider entrepreneurial attitudes and intentions.

First, knowing what to do to become an entrepreneur is not enough to foster entrepreneurial intention, as attitudes toward entrepreneurship, innovativeness and self-efficacy affect the intention. Though learning motivation is not directly associated with entrepreneurship intention, from the study, it is found the learning motivation strongly correlates with innovativeness, which in turn affects the entrepreneurship intention (Table 11). Thus, educational measures should be directed at the three attitudinal antecedents of intention, with more effort in improving the innovativeness of students. Added to this, the facilitation of learning should be taken into account, such as how to enhance the learning motivation of students, and as well the self-efficacy level.

Second, the educational measures designed for senior year students should be slightly different from those designed for junior year students. From the results (Tables 7, 9), for the senior level students, it might be attributed to their personal sense of confidence and the

purpose they acquired from their total experience in the program, whilst for junior year students, facilitation can be focused more on the development of innovativeness and learning motivation.

Thirdly, from Tables 12, 13 and Fig. 3, engineering students are found to be slightly higher in innovativeness levels, however from the model comparison (Fig. 3), though 'innovativeness' is not found significantly contributing to the 'entrepreneurial intention'. The 'attitude' and 'self-efficacy' of engineering students are found more significantly and strongly contributing to 'entrepreneurial intention'. Interestingly, the 'innovativeness' of engineering students is found significantly and strongly correlated to 'self-efficacy' and significantly to 'attitude'. From Tables 12 and 13, it can be seen that the 'attitude' of engineering students is found to be more significantly contributing to their 'entrepreneurial intention'. The interesting results may imply that engineering students, though perceiving they have higher levels of innovativeness, 'attitudes' and 'entrepreneurial intention' (Table 8). However, the critical attributes of 'entrepreneurial intention' are 'attitudes' and 'self-efficacy', whilst 'innovativeness' could be just a kind of competence, which is not the core determinant for entrepreneurship.

Fourthly, regarding the gender effect (Table 14; Fig. 4), the 'attitude' and 'innovation' (p value <0.05) are significantly different between gender groups, whilst the learning motivation (p value $= 0.078$) and self-efficacy (p value $= 0.463$) were not statistically significant. To female students, attitudes seem a lot more influencing to the entrepreneurial intention, while to male students, 'innovation' is the a lot more influencing. It may simply imply that, females students are more determined by 'attitudes', and male students are relatively on 'innovativeness'.

Conclusions

Although extensive research has been observed on entrepreneurship education, how entrepreneurship courses can be offered to engineering students remains unexplored. This study attempts to investigate the entrepreneurial intentions in association with innovativeness and attitudes. It contributes to developing appropriate education measures for entrepreneurship education among engineering students. There are some limitations in this study, such as the research model and survey design. In order to secure a high level of content validity, some items in two of the constructs are excluded. The reason could be due the size of the sample, as well the uneven numbers of different sample groups. Furthermore, the results were limited to the context of Hong Kong university students only. Future studies on entrepreneurial intentions are recommended to include students from different countries to have more representative results. Furthermore, since this study focused on the entrepreneurship intention only, the specific features and differences among different discipline groups were not included in the model. In this aspect, the research model could be further extended to incorporate those attributes.

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