

Towards Creating a Nation of Engineerpreneur

Rosnani Jusoh, Afifuddin Husairi Hussain, Fadzilah Abdul Rahman, Adi Irfan Che Ani, Haziyah Hussin

Abstract—New conceptualizations were introduced to address the emerging need to develop innovativeness and creativity attitudes in future engineering professional. Thus, entrepreneurial engineering education needs an environment where future engineers can be formed through practical learning and the interaction with forces, ideas and inspirations, in the final perspective of effectively identifying, acquiring, developing, and transferring technology into new business products and services. This paper aims to investigate the characteristics of a successful entrepreneur for engineering students. A questionnaire was used to measure the level of entrepreneurial competencies. The questionnaire was based on the Personal Entrepreneurial Competence Model, developed by McClelland Individual. Participants were recruited from the final year students of eight programs under the Faculty of Engineering. Of the 432 questionnaires distributed, 210 were collected back, giving a response rate of approximately 49%. Findings suggest that final year engineering students have respectable entrepreneurial attitudes and behaviors, and are competent to be engineerpreneur. The study also recommended that we need an environment that does not insist that engineers become entrepreneurs, but one where the two can meet, and business leaders can organize our nation effectively.

Keywords—Engineerpreneur, entrepreneurship, engineering students, higher education institutions.

I. PARADIGM SHIFT ON ENTREPRENEURSHIP EDUCATION

GLOBAL development is entering a phase where Entrepreneurship gradually plays a significant role in a country, in maintaining the economic vitality of that nation [1]. Entrepreneurship is a young developing field, with growing importance in a global business environment [2]. An old Chinese proverb says “Give a man a fish, and you feed him for a day; show him how to catch fish, and you feed him for a lifetime.” The metaphor from this proverb was wonderful for higher education, in acknowledging classical strategies to producing an entrepreneur in the 21st century. This leads to the demand for universities to manage themselves in ways that encourage their students to innovate and find new entrepreneurial solutions to economic and social development [3].

Rosnani Jusoh is with the Faculty of Educational Studies, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia (phone: 0060-1115669154; fax: 603-89468962; e-mail: rosnanijusoh@gmail.com).

Afifuddin Husairi Hussain, was with TWINTECH International University College of Technology. He is now with the Faculty of Architecture and Built Environment (e-mail: afifuddinhusairi@gmail.com).

Dr Fadzilah Abdul Rahman is with the Faculty of Educational Studies, Universiti Putra Malaysia, Kuala Lumpur, Malaysia (e-mail: fadzilah@educ.upm.edu.my).

Assoc Prof Adi Irfan Che Ani is with the Centre of Learning Accreditation, Universiti Kebangsaan Malaysia (e-mail: adiirfan@gmail.com).

Assoc Prof Dr Haziyah Hussin is with Institute of the Malay World and Civilisation, Universiti Kebangsaan Malaysia, Kuala Lumpur (e-mail: haziyah56@yahoo.com)

Innovation and entrepreneurship are vital for a flourishing economy [4]. This is with the assumption that entrepreneurship skills can be learned [5]. It involves a creative process in which individuals engage in some form of generative learning [6] and permits the acquisition of new knowledge [7], [8]. New knowledge, linked to the individual's existing understanding and business experience, results in the generation of new ideas [9]. In discussing the importance of entrepreneurship in higher education, [10] acknowledge that “It's not magic, it's not mysterious, and it has nothing to do with the genes. It's a discipline. And, like any other discipline, it can be learned.” However, [11] posits the theory that the entrepreneurial paradigm must be fundamental to survive in a globalized world. For this reason, the time is indeed ripe for higher education to develop a more entrepreneurial culture, and develop the necessary skills, attitudes, and behaviors to prepare young people to pursue opportunities as an entrepreneur” [12]. Hence, higher education institutions are expected to produce graduate students who are well equipped with entrepreneurial vision.

II. ENGINEERPRENEUR: EMERGING ENTREPRENEURSHIP IN ENGINEERING IN HIGHER EDUCATION

The entrepreneur has been defined as ‘an innovator or developer who recognizes and seizes opportunities, and converts these opportunities into workable and/or marketable ideas’ [13]. With this definition, engineering educators and policy makers agree that twenty-first century engineers need to be able to address societal problems through innovations and enhanced functionality; work in multicultural environments; understand the business context of engineering; work in interdisciplinary teams; and adapt to changing conditions [14]-[16]. There is no denying the fact that the current training mission for engineers in higher education is being continually reformed and developed. With the development of economic globalization, the contents of engineering education have been extended from the engineering sciences, technology, and management to the natural sciences, social sciences, etc. [17].

Developing the entrepreneurial intention of engineering students is important for the emergence of high-tech businesses [18], [19]. Entrepreneurial engineers not only need a rigorous engineering education, but also need to understand the elements of entrepreneurship. Young entrepreneurial engineers must know how to take advantage of the knowledge in our market place, and how to create new value [20]. The development of entrepreneurial engineering talent's ability has played an important role in the modern higher engineering educational reform, in building an innovative country, and enhancing overall national strength and competitiveness.

New conceptualizations were introduced to address the emerging need to develop innovativeness and creativity attitudes in future engineering professionals [21]. New generations of engineers are emerging, who tend to have a more autonomous approach to their careers [22]. The concepts of “entrepreneurial engineer” [23] and “global engineer” [24] highlight the great potential, existing in integrating technical and scientific backgrounds with business and value-creation skills, with the purpose of generating innovation. Engineering needs to realize an important paradigm shift, moving from the “simple” search of solutions to a proactive identification of market opportunities, driven by technology and scientific advancements. In other words, engineering graduates are expected to contribute to shaping their environment, and through numerous developments and entrepreneurial activities, generate a new demand for its products, whilst creating new clients [25]. Thus, entrepreneurial engineering education needs an environment where future engineers can be formed through practical learning and the interaction with forces, ideas and inspirations, in the final perspective of effectively identifying, acquiring, developing, and transferring technology into new business products and services. Therefore, with the use of personal entrepreneurial competencies [26], this paper aims to investigate the characteristics of a successful entrepreneur for engineering students.

III. METHODOLOGY

For this study, a questionnaire was used to measure the level of entrepreneurial competencies. The questionnaire was based on the Personal Entrepreneurial Competence Model, developed by McClelland [27]. It was developed to measure the characteristics of successful entrepreneur engineering students. All items were adapted from well-known scales, and were measured using a five-point Likert scale, ranging from one (strongly disagree) to five (strongly agree) [28].

Data was collected through a survey questionnaire, administered to full-time undergraduate prospective engineering graduates, from the Faculty of Engineering, Universiti Putra Malaysia (UPM). Participants were recruited from the final year students of eight programs under the Faculty of Engineering, such as Civil Engineering, Mechanical and Manufacturing Engineering, Electrical and Electronic Engineering, Aeronautical Engineering, Process and Food Engineering, Biological and Agricultural Engineering, Chemical and Environmental Engineering, and Computer and Communication Engineering. The questionnaire was distributed to 432 prospective engineering graduate students. An intercept data collection procedure was employed in the study. Students were accessed in their classes and study rooms. They were requested to submit their completed questionnaire at a specific centre in faculty. Of the 432 questionnaires distributed, 210 were collected back, giving a response rate of approximately 49%.

IV. FINDING

A. Demography

Table I presents the distribution composition of respondents according to the age and program.

TABLE I
 PROFILE OF RESPONDENTS

Variable	Frequency	%
Gender		
Male	108	51.4
Female	102	48.6
Age		
20-22	171	81.4
23-25	131	14.8
More than 26	8	3.8
Program		
Civil Engineering	33	15.7
Mechanical and Manufacturing Engineering	26	12.4
Electrical and Electronic Engineering	37	17.6
Aeronautical Engineering	19	9
Biological and Agricultural Engineering	30	14.3
Chemical and Environmental Engineering	28	13.3
Computer and Commucation Engineering	18	8.6
Process and Food Engineering	19	9

Table II provides an analysis of the mean score, standard deviation, and competency level, according to the cluster of entrepreneurial competency. The most striking result to emerge from the data was that the average competency level of engineering students was high. Although the respondents of this study did not receive a formal exposure to entrepreneurship as business and accounting students, the level of entrepreneurial competency attained from this research was positive.

TABLE II
 THE MEAN SCORE, STANDARD DEVIATION AND ENTREPRENEUR
 COMPETENCIES LEVEL ACCORDING TO THE CLUSTER

CLUSTER	MEAN SCORE	S.D	COMPETENCY LEVEL
Information Seeking	3.9857	0.7497	High
Concern for High Quality of Work	3.9286	0.7277	High
Persistence	3.8798	0.7967	High
Commitment to the Work Contract	3.8619	0.7822	High
Systematic Planning and Monitoring	3.8441	0.8149	High
Sees and Acts on Opportunities	3.8238	0.7353	High
Problem solving	3.7893	0.7353	High
Self-confidence	3.7619	0.7707	High
Determination	3.7262	0.8086	High
Assertiveness	3.5845	0.8326	Average
Initiative	3.5404	0.9531	Average
Use of Influence Strategies	3.4365	0.8880	Average
Average	3.7636	0.8000	High

This shows that final year engineering students have respectable entrepreneurial attitudes and behaviors, and are competent to be entrepreneurs. This also shows that the

current engineering curriculum already supports students to become engineerpreneurs.

Therefore, higher education institutions need more effort to stimulate the entrepreneurs amongst this group, to encourage innovative business start-ups and foster a culture that is friendlier towards engineerpreneurs.

The level of entrepreneurial competencies for final year engineering students is moderately high, where the highest mean score was for information seeking (3.9857). This shows that engineering students are competent to be entrepreneurs in search of new ideas and information from various sources, to help them reach objectives or clarify problems. They are also personally able to undertake research, analysis, or investigation on their own, in order to obtain information and realize their goals as entrepreneurs. Average scores (less than 3.5 mean) were obtained for assertiveness, initiative, and use of influence strategies. A possible explanation for this might be because engineering students still don't know the path to being an entrepreneur. To be a successful entrepreneur, they must be assertive in nature, so that they can assert their issues with others for the promotion of interest in their enterprises. However, the initiation of any business activity should come from the entrepreneur, and entrepreneurs should believe in systematic planning and its proper execution to reach goals. Therefore, these are three important elements towards becoming a good engineerpreneur.

V. CONCLUSION

Can engineers be entrepreneurs? Being a specialist is not a prerequisite for business success; nor does it make you an entrepreneur. The study has gone some way towards enhancing our understanding of the elements that are important to becoming a good engineerpreneur. A good entrepreneur embraces risk as an opportunity, whereas most engineers are risk averse and cautious. Engineering challenges can be extremely interesting and the mind-set required to successfully meet them is not naturally focused on risks, opportunities, and commercial value creation. Thus, with a rebounding economy, our nation needs more engineerpreneurs to accomplish current demands and solve future problems. Hence, it is time for more engineering students to take that first big step. We need an environment that does not insist that engineers become entrepreneurs, but one where the two can meet, and business leaders can organize our nation effectively

VI. RECOMMENDATION

Further research in this field would be of great help to the faculty of engineering and higher education institutions, in enhancing their quality towards creating a nation of entrepreneurial engineers. The findings of this research have a number of important implications for future practices. Therefore, several suggestions were put forward for further research:

1) This study involved engineering students at Universiti Putra Malaysia. Future research should involve more engineering students at other universities. Moreover, this

should produce a more interesting comparison of findings with the involvement of other universities.

- 2) Further research should be carried out in other institutions, such as in schools, matriculation centres, polytechnics, and Universities or Colleges.
- 3) This study uses a descriptive survey method to identify the level of students' entrepreneurial competency. Further studies need to use different approaches to obtain more analyses from different perspectives

REFERENCE

- [1] Dutta, D. K., Li, J., & Merenda, M. (2010). Fostering entrepreneurship: impact of specialization and diversity in education. *International Entrepreneurship and Management Journal*, 7(2), 163–179. doi:10.1007/s11365-010-0151-2
- [2] Co, M. J., & Mitchell, B. (2006). Entrepreneurship education in South Africa: a nationwide survey. *Education + Training*, 48(5), 348–359. doi:10.1108/00400910610677054
- [3] Li-Hua, Richard, John Wilson, Ghassan Aouad, and Xiang Li. 2011. "Strategic aspects of innovation and internationalization in higher education: The Salford PM2 experience." *Journal of Chinese Entrepreneurship* 3(1): 8–23. <http://www.emeraldinsight.com/10.1108/175613911111105990> (March 3, 2013).
- [4] Lewrick, Michael, Maktoba Omar, Robert Raeside, and Klaus Sailer. 2011. "Education For Entrepreneurship And Innovation : ' Management Capabilities For Sustainable Growth And Success '." *World Journal of Entrepreneurship, Management and Sustainable Development* 6(1): 1–18.
- [5] Kuratko, D.F. (2005), "The emergence of entrepreneurship education: development, trends and challenges", *Entrepreneurship Theory & Practice*, Vol. 29 No. 5, pp. 577-98.
- [6] Chaston, Ian, and Gregory J. Scott. 2012. "Entrepreneurship and open innovation in an emerging economy." *Management Decision* 50(7): 1161–1177. <http://www.emeraldinsight.com/10.1108/00251741211246941> (March 25, 2013).
- [7] Miller, D. (1983), "The correlates of entrepreneurship in three types of firm", *Management Science*, Vol. 29, pp. 671-82.
- [8] Popper, M. and Lipshitz, R. (1998), "Organizational learning mechanisms: a structural and cultural approach to organizational learning", *Journal of Applied Behavioral Science*, Vol. 34, pp. 161-79.
- [9] Ogez, F. (2001), "How entrepreneurs learn? A practical interpretation", *METU Studies in Development*, Vol. 28 Nos 1/2, pp. 183-202.
- [10] Drucker, P.F. (1985) *Innovation and entrepreneurship*, Harper & Row, New York.
- [11] Kyro, P. (2000) *Is there a Pedagogical Basis for Entrepreneurship Education?* Department of Economics, Jyväskylä University, Finland, pp.1–18.
- [12] Wilson, K. (2009), "Executive summary", in Volkmann, C., Wilson, K.E., Mariotti, S., Rabuzzi, D., Vyakarnam, S. and Sepulveda, A. (Eds), *Educating the Next Wave of Entrepreneurs: Unlocking Entrepreneurial Capabilities to Meet the Global Challenges of the 21st Century*, World Economic Forum, Geneva.
- [13] Kuratko, D., 1995. *Entrepreneurship in international encyclopedia of business and management*. London, UK: International Thomson Press.
- [14] Kauffman Foundation (2008). *Kauffman Thoughtbook 2009*. Kauffman Foundation.
- [15] National Academy of Engineering (2005). *The Engineer of 2020: Visions of Engineering in the New Century*. Washington, D.C.: National Academies Press.
- [16] National Science Board (2007). *Moving Forward to Improve Engineering Education*. Washington, D.C.: National Science Foundation.
- [17] Shu-yu, G., & Xiao-dong, Z. (2011). *The Exploration for the Development Models of Engineering Entrepreneurship*. International Conference on Management and Service Science (MASS).
- [18] Roberts, E.B. (1991), *Entrepreneurs in High Technology: Lessons from MIT and Beyond*, Oxford University Press, Oxford.
- [19] Shane, S. (2000), "Prior knowledge and the discovery of entrepreneurial opportunities", *Organization Science*, Vol. 11 No. 4, pp. 448-69.
- [20] Wang, Y., & Verzat, C. (2011). *Generalist or specific studies for engineering entrepreneurs?: Comparison of French engineering students'*

- trajectories in two different curricula. *Journal of Small Business and Enterprise Development*, 18(2), 366–383. doi:10.1108/14626001111127124
- [21] Elia, G., Margherita, A., Secundo, G., & Moustaghfir, K. (2011). An “Activation” Process for Entrepreneurial Engineering Education: the Model and Application. *Journal of Enterprising Culture*, 19(02), 147–168. doi:10.1142/S0218495811000738
- [22] Wang, Y., & Verzat, C. (2011). Generalist or specific studies for engineering entrepreneurs?: Comparison of French engineering students’ trajectories in two different curricula. *Journal of Small Business and Enterprise Development*, 18(2), 366–383. doi:10.1108/14626001111127124
- [23] Creed, C. J., Suuberg, E. M. and Crawford, G. P. (2002). Engineering entrepreneurship: An example of a paradigm shift in engineering education, *Journal of Engineering Education* 91(2): 185–195.
- [24] McMasters, J. H. (2006). *Thoughts on the Engineer of 2020 An Early 21st Century (Aerospace) Perspective*. Chicago: Boeing Corporation.
- [25] Polczynski, M. and Jaskolski, S. (2005). *Entrepreneurial Engineering Education*, The NCIIA 9th Annual Meeting, San Diego, CA, March.
- [26] McClelland, D. C. 1987. Characteristics of successful entrepreneurs, *Journal of Creative Behavior*. 21(1), 18-21.
- [27] Mansfield, R. S., McClelland, D.C., Spencer, L. M., and Santiago, J. (1987). The identification and assessment of competencies and other personal characteristics of entrepreneurs in developing countries, Final Report: Project No. 936-5314, *Entrepreneurship and Small Enterprise Development*, Contract No. DAN-5314-C-00-3065-00. Washington, DC: United States Agency for International Development: Boston: McBer.
- [28] Kumar, R. (2010). *Research Methodology: A Step-by-Step Guide for Beginners*. United Kingdom: SAGE Publications Ltd.