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Determinants of the entrepreneurial self-efficacy of engineering students from a South African university of technology

Tiyamike Ngonda & Virginia Ngonda

Cape Peninsula University of Technology
Bellville, South Africa

ABSTRACT: The authors of this article investigate the links between entrepreneurial role models, entrepreneurship education and the entrepreneurial self-efficacy of engineering students from South Africa. The study reported in this article used census sampling to collect data from 410 undergraduate engineering students at a South African university, representing a 7% response rate. The data were analysed using covariance-based structural equation modelling (CB-SEM). The study found a significant positive relationship between entrepreneurial role models and entrepreneurial self-efficacy, and between entrepreneurship education and entrepreneurial self-efficacy. It confirmed the importance of entrepreneurship education and entrepreneurial role models in enhancing entrepreneurial self-efficacy, consistent with previous research. However, the results did not establish a relationship between entrepreneurial role models and entrepreneurship education. The results suggest that curriculum developers should consider including guest lectures and networking opportunities in entrepreneurship education programmes. They should utilise entrepreneurial role models similar to the students or from the same communities.

Keywords: Entrepreneurial role models, entrepreneurship education, entrepreneurial self-efficacy, engineering students, covariance-based structural equation modelling

INTRODUCTION

There is a growing interest in understanding the antecedents of entrepreneurial self-efficacy (ESE) [1]. The interest is motivated by literature that shows that ESE is a crucial antecedent of entrepreneurial intentions (EI) [2][3]. The significance of ESE is collaborated by the two leading theories on EI, Ajzen's theory of planned behaviour and Shapero-Krueger's entrepreneurial event model. ESE refers to an individual's belief in their ability to start and run a successful business venture [3]. When considered in their totality, these studies suggest that an individual's ESE is revealed by influencing their EI, thereby increasing the chances of choosing entrepreneurship instead of seeking employment. Prior research indicates that entrepreneurship education (EE) and entrepreneurial role models (ERM) significantly influence an individual's ESE [4].

In the past, entrepreneurship was considered un-teachable due to its contextual and serendipitous nature. Recently, it has become clear that entrepreneurship can be taught. It is not surprising that entrepreneurship education has experienced tremendous growth over the past few decades, particularly in Europe and the United States [5][6]. In the US, initiatives such as the Kern Entrepreneurial Engineering Network (KEEN) have been formally adopted in engineering education [6].

In Europe, the European Commission developed a comprehensive strategy called Entrepreneurship Action Plan 2020 to promote entrepreneurship across EU member countries [7]. The plan recognises EE's importance and seeks to incorporate it into all university education. However, the integration of EE into engineering education has mostly been confined to developed countries. These developments are not widespread in developing countries, including South Africa.

This study investigates the relationship between EE, ERM and ESE of engineering students from a South African university. European and US studies have explored the links between the three concepts. However, there is a lack of African literature on the subject. Additionally, there is no consensus in the literature on the links among EE, ERM and ESE, with some studies indicating a positive relationship, whereas others do not. In this article, the authors seek to fill these gaps and contribute to the literature on the relationship between EE, ERM and ESE among engineering students in South Africa. Given that entrepreneurship is contextual, findings from Southern Africa would increase confidence in the impact of EE and ERM on ESE. It would also assist universities in structuring their EE programmes to enhance ESE, which is needed by entrepreneurs to create jobs and provide additional opportunities for employment and another source of tax revenue.

Entrepreneurial Self-efficacy

ESE developed from the concept of self-efficacy, which Bandura introduced in the 1970s as part of his social cognitive theory [8]. Self-efficacy is the belief in one's capabilities to organise and execute actions required to accomplish a specific task or achieve a particular goal [8]. It influences the course of action one chooses to pursue, the effort one exerts, and how much one perseveres in facing challenges and failures.

In entrepreneurship, self-efficacy reflects an individual's confidence in their ability to engage in entrepreneurial activities successfully. To enhance the predictive power of the self-efficacy concept, a domain-tailored measure of self-efficacy, ESE, is employed [9]. Prior research shows that individuals with higher ESE also have higher EI [1][3]. Previous research has also demonstrated that EI mediates between personal characteristics and EI [3]. In addition, some studies have shown that ESE influences career choice, with individuals with high ESE being more likely to choose entrepreneurship.

Entrepreneurship Education

Several previous studies have suggested that participation in EE enhances the ESE of undergraduate students [3][4]. Participating in EE provides students with opportunities for mastery and vicarious experiences, and social persuasion, in addition to giving them entrepreneurial skills and knowledge [10].

However, EE can be categorised into education about entrepreneurship, education for entrepreneurship and education in entrepreneurship. Some studies argue that EE does not have ESE-enhancing capabilities [11]. They argued that education for entrepreneurship (focusing on knowledge and skills needed to start a business) is more likely to lead to increasing ESE than education about entrepreneurship (focusing on theories on entrepreneurship) [11]. It is evident from this that EE needs to combine theoretical knowledge with developing practical skills through pedagogies, including problem-based learning, guest lectures by successful entrepreneurs and internships at start-ups [3][6][7][10].

H1: Entrepreneurial knowledge positively influences entrepreneurial self-efficacy.

Entrepreneurial Role Models

Contextual factors, such as exposure to entrepreneurial activity, partially influence individuals' interest in entrepreneurship [12]. According to social learning theory, individuals learn by observing and imitating others, particularly those seen as role models. It is generally accepted in the literature that a successful ERM has a considerable influence on individual intentions to become entrepreneurs [13]. The contrary is also possible. Those exposed to negative entrepreneurial experiences, such as the business failure of family and friends, may be discouraged from pursuing entrepreneurship [12].

Individuals tend to identify with others they see as inspirational and similar to themselves. EE could be valuable in this modelling behaviour, linking students with successful entrepreneurs from their communities. Previous studies found that effective role models tend to be family members, friends and successful entrepreneurs within the community [13][14]. Prior studies suggest that the influence of ERM is more pronounced if individuals and role models live in the same geographic area [14] In addition, the perceived similarity in personal attributes, such as gender, ethnicity, field of expertise and age between the individual and the ERM is vital to ESE enhancement [14].

H2 Entrepreneurial role models positively influence entrepreneurial self-efficacy.

H3 Entrepreneurial role models positively influence entrepreneurship education.

Figure 1 summarises the conceptual framework for this study. The model extends previous models by exploring ERM and EE's influences on ESE among engineering students from a developing country. It does this while focusing on the effect of ERM on practical EE.

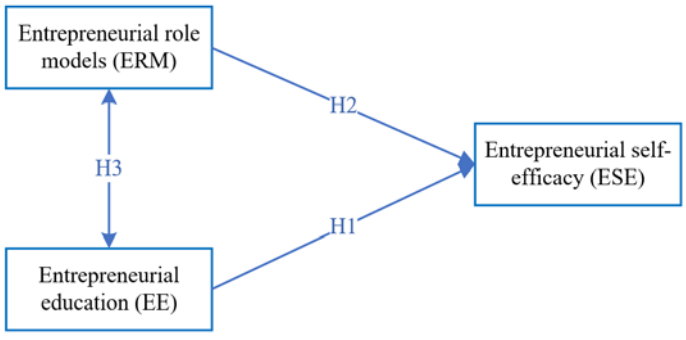

Figure 1: Conceptual model of the relationship between entrepreneurial role models, entrepreneurship education and entrepreneurial self-efficacy.

METHODOLOGY

Sample and Data Collection

The study obtained ethical approval before participant recruitment. It then used census sampling and invited all 6,261 undergraduate engineering students at a South African university. The survey collected responses in March 2023. It received 443 responses by its close, representing a 7% response rate. After removing incomplete responses and duplicates, the study remained with 410 usable responses.

Table 1 presents the profile of the final sample. The respondents were 41% female, 95% in their third year or less and 97% younger than 30. Most of the respondents were studying mechanical engineering (30%), then civil engineering (19%), electrical and computer engineering (15%) and chemical engineering (10%). The departments of industrial engineering, construction management, and clothing and textile technology contributed less than 10% of the respondents each.

Table 1: Summary of the profiles of the participants.

Discipline	Gender		Year of study					Age				Received training in entrepreneurship	
	Female	Male	1	2	3	4	5	16 - 20	21 - 25	26 - 30	> 30	Yes	No
Chemical engineering	20	20	16	9	15	1	0	12	24	3	2	7	34
Mechanical engineering	31	94	44	44	31	4	0	47	68	7	2	21	103
Electrical and computer Engineering	21	43	34	21	6	6	6	24	31	8	2	11	54
Industrial engineering	18	17	12	13	10	1	0	18	16	2	0	5	31
Civil and geomatics	41	38	32	26	20	1	0	35	37	4	3	9	70
Construction management and quantity surveying	20	28	18	13	10	7	0	15	20	10	3	9	39
Clothing and textile technology	18	7	11	10	3	1	0	7	13	4	1	6	19

Measures

The measures used were adapted from existing scales found in the literature.

Data Analysis

The conceptual model was analysed using covariance-based structural equation modelling (CB-SEM). CB-SEM methodology requires an assessment of the measurement model, followed by that of the structural model. The study used IBM SPSS Amos version 29 for the CB-SEM.

RESULTS

This section presents a descriptive summary of responses and the results from analysing the measurement and structural models. The study used IBM SPSS Amos version 29 for the CB-SEM. Table 2 presents the mean and standard deviations of the responses. Question ESE 1 to ERM 3 were measured on a 7-point Likert scale, whereas questions EE 1, EE 2 and EE 3 were *yes* (labelled 1) and *no* (labelled 0) questions.

Table 2: Means and standard deviations of the responses received in the survey.

		Mean	SD
ESE 1	I think it is easy to start my own business.	3.63	1.770
ESE 2	I think it is feasible for me to start a business.	4.65	1.654
ESE 3	I have the ability to start a business.	5.32	1.676
ERM 1	I have immediate family who inspire me to be an entrepreneur.	5.15	1.739
ERM 2	I have friends who inspire me to be an entrepreneur.	5.80	1.521
ERM 3	I know people in the community who inspire me to be an entrepreneur.	5.93	1.440
EE 1	I have the knowledge needed to source funds for my business idea.	0.16	0.366
EE 2	I have knowledge needed to set-up and register my business.	0.30	0458
EE 3	I have knowledge needed to market my products or services.	0.36	0.480

Measurement Model

The model includes three multi-item constructs (ERM, EE and ESE). First, a confirmatory factor analysis was done to assess the factor loadings of the items of each construct. Four items that had low factor loadings (< 0.50) were removed. After removing the factors, the confirmatory factor analysis was redone, and all remaining items were retained (factor loading > 0.5). Second, the reliability of the constructs was measured by Cronbach's alpha (α) and composite reliability (CR). The results showed shows that ERM (CR = 0.843, and α = 0.794) and ESE (CR = 0.719 and α = 0.703) had CR and Cronbach's alpha above the recommended (CR = 0.7 and α = 0.7). The values for EE (CR = 0.559 and α = 0.609) were less than the recommended minimum. Lastly, the convergent validity was measured using average variance extracted (AVE). All the constructs had AVEs greater than the recommended.

Structural Model

The analyses of the structural model had two components: model fit and hypothesis testing. Model fit was assessed using goodness-of-fit indices. All the indices were within range (chi-square (CMIN) = 97.694, df = 24, *p*-value = 0.000, CMIN/df = 4.071, GFI = 0.950, CFI = 0.937, TLI = 0.906 and RMSEA = 0.076). Figure 2 presents the results of the path analysis.

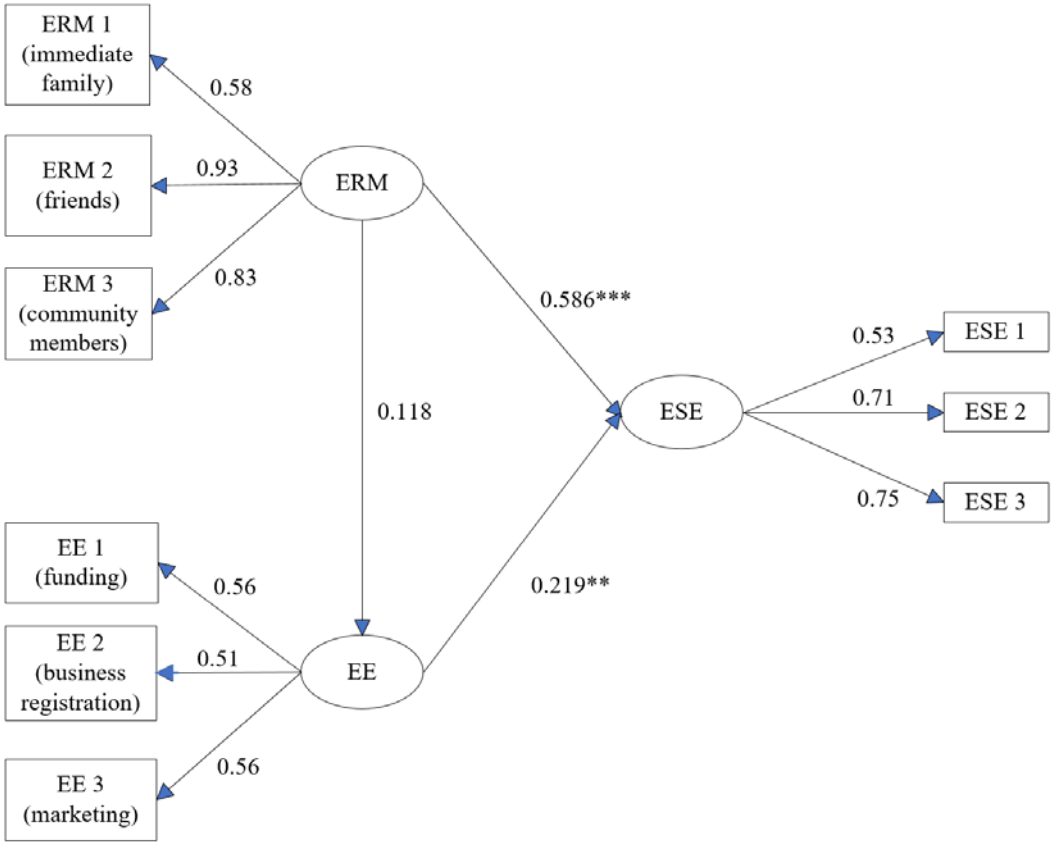

Figure 2: Results of the structural model linking entrepreneurial role models, entrepreneurship education and entrepreneurial self-efficacy.

Three hypotheses were tested at a significance level of $p = 0.05$. Table 3 summarises the results.

Table 3: Hypotheses testing results for the structural model linking entrepreneurial role models, entrepreneurship education and entrepreneurial self-efficacy.

Hypothesis	Path coefficient (β)	*p*-value
H1: Entrepreneurship education → Entrepreneurial self-efficacy	0.219	0.013**
H2: Entrepreneurial role models → Entrepreneurial self-efficacy	0.586	***
H3: Entrepreneurial role models → Entrepreneurship education	0.118	0.463

The study's first hypothesis was that entrepreneurship education positively influences entrepreneurial self-efficacy. The results support this hypothesis ($\beta = 0.219$, $p = 0.013 < 0.05$). However, caution should be exercised in interpreting this finding because of the reliability and validity problems with the measurement of entrepreneurship education. The second hypothesis was that entrepreneurial role models positively influence entrepreneurial self-efficacy. The results support this hypothesis ($\beta = 0.586$, $p < 0.001$). The last hypothesis of the study was that entrepreneurial role models positively influence entrepreneurship education. This hypothesis was not supported ($\beta = 0.118$, $p = 0.463 > 0.05$).

DISCUSSION

This study investigated the relationship between entrepreneurship education, entrepreneurial role models and entrepreneurial self-efficacy of engineering students at a South African university. It found that entrepreneurial role models significantly and positively influence entrepreneurial self-efficacy. These findings are consistent with previous research demonstrating the positive impact of entrepreneurship education and entrepreneurial role models on entrepreneurial self-efficacy [3][10][11]. It also found that entrepreneurial role models do not significantly influence entrepreneurship education. This finding is inconsistent with previous studies [13]. Setiadi et al suggest that engineering students might respond better to entrepreneurship education, which teaches creativity and innovation [15].

The results support entrepreneurial role models' positive impact on university students' entrepreneurial self-efficacy [13]. It adds South Africa to the countries where studies have confirmed the importance of entrepreneurial role models in promoting entrepreneurship. Given the findings from previous studies [14], it was not surprising that the students were inspired by their immediate family and friends. However, it was surprising that community members had a higher factor loading than extended family members. This inconsistency might reflect the changing structure of South African communities. The students might have had fewer interactions with extended family to consider them as entrepreneurial role models.

IMPLICATIONS

The findings have several implications for engineering education practice and research. First, the study confirms that entrepreneurial role models enhance engineering students' entrepreneurial self-efficacy. Second, it suggests that curriculum developers should consider the value and include guest lectures and networking opportunities when designing entrepreneurship education programmes. Also, they should emphasise utilising entrepreneurial role models who are peers or from the same communities as the students rather than unrelated models.

LIMITATIONS AND FUTURE RESEARCH

This study has several limitations. First, it collected data from a single university in South Africa, which may affect the representativeness of the findings. Future research should address this shortcoming by collecting data from multiple universities.

Second, the response rate was low, below 10%. Future studies should consider providing a longer window for collecting responses and perhaps providing incentives to increase the response rate.

Thirdly, the study was limited by unreliable instruments for entrepreneurship education and entrepreneurial role models for engineering students. Future research should focus on developing and validating instruments for these concepts.

Lastly, the study ignored the differences in how various engineering programmes implement entrepreneurship education. This might have affected the reliability and validity of the measure for entrepreneurship education. Future research should account for personal and programme characteristics in studying links between the three constructs.

CONCLUSIONS

This study has shown that entrepreneurial role models significantly and positively influence the entrepreneurial self-efficacy of engineering students at a South African university. It also confirms the importance of entrepreneurship education in enhancing entrepreneurial self-efficacy, consistent with previous research.

These findings have important implications for engineering education practice and research. They suggest that curriculum developers should consider including guest lectures and networking opportunities in entrepreneurship education programmes.

They should use entrepreneurial role models who are similar or from the same communities as the students. By doing so, students may be better motivated and inspired to develop their entrepreneurial skills and self-efficacy. However, this study has limitations in that it collected data from a single university in South Africa and used invalidated instruments for measuring entrepreneurship education and entrepreneurial role models. Future research should address these limitations.

Overall, this study provides valuable insights into the importance of entrepreneurial role models and entrepreneurship education in enhancing the entrepreneurial self-efficacy of engineering students in South Africa.

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BIOGRAPHIES

Tiyamike Ngonda graduated with a Bachelor of Science in mechanical engineering (with distinction) from the University of Malawi, Zomba, Malawi, in 2001, Master of Engineering (with distinction) from the University of the Witwatersrand, South Africa, in 2004 and Doctor of Philosophy from the University of Cape Town, South Africa, in 2020. Dr Ngonda is a professional mechanical engineer registered with the Engineering Council of South Africa. He has worked as a lecturer at several universities in Southern Africa. He is currently a senior lecturer in mechanical engineering at Cape Peninsula University of Technology, South Africa. Dr Ngonda has published in peer-reviewed journals and conference proceedings. His research focuses on engineering education, thermodynamics, renewable energy and materials science.

Virginia Ngonda graduated with a Bachelor of Technology in project management from the Central University of Technology, South Africa, in 2008 and a Master of Technology in project management from the Cape Peninsula University of Technology, South Africa, in 2018. Ms Ngonda is a doctoral candidate in project management at the Cape Peninsula University of Technology. She has worked at several universities in South Africa and is currently working in the Department of Industrial and Systems Engineering at the Cape Peninsula University of Technology. Ms Ngonda has published in conference proceedings. Her research focuses on project management, sustainability, diffusion of innovations and structural equation modelling.