2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #38173

Measuring Engineering Students' Entrepreneurial Self-Efficacy in an Entrepreneurship Education Program

Dr. Ying Wang, Georgia Institute of Technology

Ying Wang is a Postdoctoral Fellow in CREATE-X and the College of Engineering at the Georgia Institute of Technology since Fall 2021. She earned her Ph.D. in Educational Psychology at The Pennsylvania State University and Master of Education at Temple University. Ying is an educational psychologist who conducts research on examining how students learn and the effective ways to support students' learning and their academic and professional successes.

Dr. Joy Harris
Karthik Ramachandran, Georgia Institute of Technology

Measuring Engineering Students' Entrepreneurial Self-Efficacy in an Entrepreneurship Education Program

Abstract

In this research paper, we developed and examined an Entrepreneurial Self-Efficacy for Engineering Students (ESE-E) instrument. Entrepreneurial self-efficacy refers to individuals' perceived capabilities to perform entrepreneurial tasks and produce entrepreneurial-related outcomes. It is critical to develop and test the measurement of entrepreneurial self-efficacy with the engineering student population. Further, entrepreneurship education programs are increasing and play a crucial role in engineering education. In the present study, students enrolled in an entrepreneurship education course were from various engineering schools. Overall, the instrument development included four steps. First, our research team conducted an extensive literature review on entrepreneurial self-efficacy in engineering education. Second, we piloted the original entrepreneurial self-efficacy instrument to a small group of students in the entrepreneurship education course. Third, based on the results and feedback we received from the pilot study, we collaborated with the course instructor to modify and add items that aligned with the course content and prior research. Third, we administered the revised instrument to students enrolled in the entrepreneurship education program at the university. Through exploratory factor analysis, the ESE-E demonstrated a 7-factor solution. Factors included *product ideation, business planning, customer discovery, team and network formation, idea pitch, people and human resources,* and *finance.* Additionally, correlational analyses demonstrated that these seven factors were related to each other positively. This means that if students are confident about one entrepreneurial-related skill described in this instrument, they are likely to feel confident about other entrepreneurial-related skills described in the instrument. Further and interestingly, students with a growth creative mindset tended to have high self-efficacy for product ideation, team formation, and people and human resources. This means students who believe they can learn to be creative are likely confident about certain entrepreneurial skills. The present study contributed an appropriate instrument for measuring engineering students' entrepreneurial self-efficacy to the literature. Future directions and implications are discussed.

Introduction

Self-efficacy refers to one's belief in their capabilities to perform or complete certain tasks (Bandura, 1977, 1986, 1997). Individuals who have high self-efficacy beliefs toward a certain task tend to perform well on that task (Schunk, 1989). Similarly, within the fields of entrepreneurship and entrepreneurship education, entrepreneurial self-efficacy refers to individuals' perceived capabilities to perform entrepreneurial-related tasks and produce entrepreneurial-related outcomes (Chen et al., 1998). Prior research has suggested that individuals with high entrepreneurial self-efficacy (ESE) tend to engage in entrepreneurial activities and become entrepreneurs (Asimakopoulos et al., 2019; Krueger et al., 2000; Shekhar & Huang-Saad, 2021). As such, ESE is a critical construct to investigate in entrepreneurship education. While there are existing entrepreneurial self-efficacy assessment tools in the literature (e.g., Chen et al., 1998; McGee et al., 2009), few have been examined with engineering students within a specific entrepreneurship education course. Given that self-efficacy beliefs are task- and context-specific (Bandura, 1986; 2006), the lack of an ESE instrument for engineering students in an entrepreneurship education program specifically is critical and needs to be addressed. Therefore, in the present study, we adapted an existing ESE instrument for engineering students in an entrepreneurship education program at a large southeastern university in the United States and examined the psychometric properties of the instrument.

In the field of engineering education, there has been an increasing number of entrepreneurship education programs. Engineering educators have identified the link between entrepreneurship and engineering and realized the importance of entrepreneurial-related skills, such as creativity and leadership skills (Da Silva et al., 2015; Wang & Kleppe, 2001). However, according to a recent systematic review, the existing entrepreneurship education programs in engineering have not been well-defined, measured, and evaluated (Zappe et al., 2023). Given that ESE is a critical construct that can affect engineering students' learning in entrepreneurship, an ESE instrument for college engineering students is timely needed. In addition, with a well-established assessment tool for students' ESE, engineering researchers and practitioners can measure students' self-efficacy for entrepreneurial-related activities and skills through a data-driven approach and improve future entrepreneurship education programs. In the present study, we developed and examined an *Entrepreneurial Self-Efficacy for Engineering Students* (ESE-E) instrument. Specifically, we incorporated findings of a previous study on examining engineering faculty and students' perceived important content topics in entrepreneurship education (Besterfield-Sacre et al., 2016), a self-report instrument created by McGee et al. (2009), and the specific content topics taught in the entrepreneurship education course in a university. With such incorporation of existing literature and the actual specific course content in an entrepreneurship education program, we aimed to develop a valid and reliable assessment tool for measuring and improving students' ESE in engineering education.

Dimensions of Self-Efficacy

We were guided by Bandura's self-efficacy theory originated from Bandura's (1986) social cognitive theory. Social cognitive theory suggests the triadic reciprocal determinism with personal factors, behavior, and environmental factors. In other words, social cognitive theory suggests that an individual's personal factors (e.g., knowledge, self-efficacy), behavior, and environmental factors interact with and affect one another dynamically. Self-efficacy is considered as one personal factor; however, one's formation of self-efficacy beliefs is

determined by their behavior and the environment. Reciprocally, one's self-efficacy beliefs affect their behavior and how one interacts with a certain environment. Therefore, it is important and necessary to examine students' self-efficacy beliefs within a certain engineering entrepreneurship education context instead of examining students' general self-efficacy beliefs.

In particular, the self-efficacy theory emphasizes human agency and individuals' perceptions of their capabilities (Bandura, 1977; 1997). Additionally, self-efficacy includes three dimensions: magnitude, strength, and generality. Specifically, the dimension of magnitude refers to task difficulty. For example, individuals may perceive lower self-efficacy when performing a more difficult task than an easier task. Further, strength refers to the extent to which an individual is certain about performing a specific task. In other words, individuals who are more certain about being able to perform a task demonstrate higher self-efficacy. Finally, generality refers to the extent to which one's self-efficacy belief is related to a specific situation or context. According to Bandura (1997), one's self-efficacy is more accurately perceived when the context is more specific. Accordingly, we adapted and created the ESE-E to reflect these three dimensions.

In terms of the dimension of magnitude, the ESE-E scales included items that measured entrepreneurial-related skills and activities at various difficulties, such as *product ideation, business planning, and customer discovery*. Furthermore, in terms of the dimension of generality, we adapted the items and created additional items based on the specific content topics taught in an entrepreneurship education course. In addition, in terms of the dimension of strength, each ESE-E item asked students to indicate how confident they were in performing a specific entrepreneurial-related task. As such, the dimension of strength can be examined by comparing students' reported confidence scores in items of the ESE-E.

The Present Study

According to the original ESE scales by McGee et al. (2009), the factors included *searching, planning, implementing-people, implementing-financial, marshaling, and attitude toward venturing*. We expected a similar factor structure of the ESE-E scales; however, because we adapted the scales based on the specific topics taught in the entrepreneurship education program, we also expected new factors that reflected our program. In terms of examining the criterion validity of the ESE-E scales, we also examined students' creative mindsets. Specifically, creative mindsets refer to whether students believe their creativity is innate or adaptive. We measured engineering students' creative mindsets because creative mindsets are an important component in both engineering and entrepreneurship and are expected to be related to students' entrepreneurial self-efficacy beliefs (Cropley, 2016; Walton, 2003). In the present study, overall, we created the ESE-E following multiple iterations and theoretical and empirical guidelines. Therefore, we expected that the scales would demonstrate high reliability and validity.

Research Questions

As such, we had three research questions:

1. What are the factors of the ESE-E scales?
2. Are students' creative mindsets related to their entrepreneurial self-efficacy?

3. How reliable are the Entrepreneurial Self-Efficacy for Engineering Students (ESE-E) scales?

Method

Scale development protocol

Overall, we followed Messick's (1995) guide on scale development and validation. Such a scale development guide was also followed by recent self-efficacy instruments for writing (Sun et al., 2022; Varier et al., 2021). We considered the development of an instrument requires multiple phases, such as theoretical and empirical grounding of the target construct, pilot testing, and obtaining various types of validity evidence according to the *Standards for Educational and Psychological Testing* (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014). Specifically, our scale development for the ESE-E included four phases: 1) literature review, 2) item piloting, 3) item creation and modification, and 4) examining psychometric properties. The development process was iterative and involved multiple item additions and modifications.

Phase 1: Literature review

In Phase 1, our research team conducted an extensive literature review on ESE in engineering education. Prior research has demonstrated that ESE is a critical construct in promoting students' entrepreneurial-related skills in entrepreneurship education and there are several existing instruments that can be used to assess students' ESE (e.g., Anna et al., 1999; Barbosa et al., 2007; Chen et al., 1998; Krueger et al., 2000). However, the existing instruments mostly focused on business students, the general student population, or people who were already entrepreneurs. In addition, the factor structure of ESE from the existing instruments has not been consistent (McGee et al., 2009). Specifically, McGee et al. (2009) extensively reviewed 25 empirical studies that used an ESE measure. However, few ESE instruments were designed or used for engineering student populations within an engineering entrepreneurship program. In addition, although ESE has been examined in engineering education research recently, a validation study of a self-report ESE instrument for engineering students is still lacking based on our literature review. For example, Asimakopoulos et al. (2019) examined engineering students' ESE using a quantitative method. However, it was not clear whether the ESE instrument adopted in their study measured individuals' self-concept or self-efficacy, and the items were not created to reflect the content of general entrepreneurship education programs. Therefore, based on prior research, a theoretically and empirically grounded ESE instrument for engineering students is timely needed. Based on the refined ESE instrument by McGee et al. (2009), we adapted and created items that assessed engineering students' ESE.

Phase 2: Item piloting

In Phase 2, we aimed to pilot the items that were consistent with the entrepreneurship education course content from McGee et al. (2009). Specifically, based on the feedback received from the course instructors and the curriculum creator of the entrepreneurship education course, we selected 10 items from McGee et al. (2009) and created two additional items that reflected the course content topics. The 12 items were administered to students in Spring 2022. We then

collected course instructors' feedback on how they perceived these items with the course content they taught. See Appendix for the selected 10 items from McGee et al. (2009).

Phase 3: Item creation and modification

In Phase 3, based on the results and feedback we received from the pilot study, the previous version of the ESE instrument did not fully cover all the content topics taught in the course and the program. Therefore, we continued to collaborate with the course instructor to modify and add items that aligned with the course content topics (e.g., customer discovery). We also compared the content topics covered in the present course to prior research. Specifically, we adopted the research findings reported by Besterfield-Sacre et al. (2016). For example, Besterfield-Sacre et al. (2016) conducted a survey with engineering faculty and students in an entrepreneurship education program and reported that engineering faculty and students perceived that entrepreneurship courses should focus on both entrepreneurial knowledge and skills (Besterfield-Sacre et al., 2016). Therefore, accordingly, in the present study, in addition to creating items that reflected the actual content topics taught in the entrepreneurship education course, we included items focused on both entrepreneurial knowledge and skills that are often included in entrepreneurship education programs in general. As a result, we had a total of 32 items. Further, during item creation, we followed the self-efficacy construction guide by Bandura (2006) to ask students to indicate their confidence or perceived capability of doing a certain activity using a 100-point scale with 10 intervals.

Phase 4: Examining psychometric properties

In Phase 4, we administered the revised instrument to a large student sample enrolled in the entrepreneurship education program at the university in the following semester. After the data collection, we conducted an exploratory factor analysis to examine the factor structure of the ESE-E scales and the reliability of the scales. Specifically, we investigated whether the scales with modified and added items were consistent with the course content and prior research. We also examined the relation between ESE and creative mindsets to examine concurrent validity as additional validity evidence. Concurrent validity is a type of criterion validity, which refers to the extent to which two relevant measures are in agreement (Gall et al., 2007). In other words, if a new measure is correlated with one relevant existing measure, it shows concurrent validity. As such, we examined the correlation between creative mindsets and ESE-E because these two latent constructs are suggested to be correlated according to prior research.

Participants

In the pilot data collection, participants included 32 students who enrolled in various schools of engineering at the university. Specifically, 56.3% of students (n = 18) reported as men, 41.9% of students reported as women (n = 13), and 3.1% of students (n = 1) did not report their gender. Overall, 43.7% of students (n = 14) reported White, 37.5% of students (n = 12) reported Asian, 9.4% of students (n = 3) reported Hispanic/Latino, 3.1% (n = 1) of students reported Black or African American, 3.1% of students (n = 1) reported more than one race or ethnicity, and 3.1% of students (n = 1) did not report any information. Further, 74.2% of students (n = 23) were undergraduate students, 25.0% of students (n = 8) were graduate students, and one student did not report their academic standing.

In the formal data collection, participants included 96 engineering students across schools who enrolled in the entrepreneurship education program at the university. Specifically, 72.8% of students (n = 67) reported as men, 26.0% of students reported as women (n = 25), and 4.2% of students (n = 4) did not report their gender. In terms of race and ethnicity, 39.6% of students (n = 38) reported Asian, 35.4% of students (n = 34) reported White, 11.5% of students (n = 11) reported Black or African American, 6.3% of students (n = 6) reported more than one race or ethnicity, 2.1% of students (n = 2) reported Other, and 5.2% of students (n = 5) did not report any information. Further, 40.2% of students (n = 37) were undergraduate students and 40.2% of students (n = 37) were graduate students. Additionally, 12.5% of students (n = 12) were recent alumni, 3.1% of students (n = 3) were non-affiliated students, 3.1% of students (n = 3) reported Other, and 4.2% of students (n = 4) did not report their academic standing.

Measures and materials

Entrepreneurial self-efficacy with engineering students (ESE-E)

The ESE-E was adapted from McGee et al. (2009). In the following semester, we administered the ESE-E adapted by our research team. Specifically, the ESE-E included 32 items that assessed *product ideation, business planning, customer discovery, team and network formation, idea pitch, people and human resources, and finance*. Students were asked to indicate their confidence in each item from 0 (not confident at all) to 100 (very confident).

Creative Mindsets

In addition to the ESE-E, we also administered the creative mindsets instrument (Karwowski, 2014). The creative mindsets instrument was created to measure whether students believe their creativity is innate or malleable through learning. Specifically, the creative mindsets included 10 items with five items measuring a growth creative mindset and five items measuring a fixed creative mindset. Students were asked to respond to each item on a 4-point Likert-type scale ranging from 1 (Almost never) to 4 (Almost always). A sample item is "*Anyone can develop their abilities up to a certain level*." The internal consistency of a growth creative mindset was .68 and a fixed creative mindset was .76.

Analytic approach

Overall, we used a quantitative approach to address the research questions. Primarily, we conducted exploratory factor analyses to investigate the factor structure of the ESE-E. We chose to conduct EFA because the ESE-E is a new instrument without an established framework. We created the instrument based on the course content and instructors' feedback. Due to its exploratory nature, we considered that EFA was a proper analytical approach for this study. Additionally, we also conducted correlation analyses to examine the concurrent validity of the ESE-E. The data source for the quantitative analyses was the data collected through the formal data collection. All data analyses were conducted using JASP (2023), a statistical analysis software.

Results and discussion

Research Question 1: What are the factors of the ESE-E scales?

In order to answer the first research question, we conducted an exploratory factor analysis with the maximum likelihood estimation and an oblique rotation to extract factors with eigenvalues greater than one. The Kaiser-Meyer-Olkin (KMO) test demonstrated that 30 out of 32 items had a KMO value greater than .80 and two items had a KMO value greater than .75. This indicated that the sample size was adequate and all the ESE-E items were appropriate to proceed to conduct exploratory factor analysis (Kaiser, 1974; Tabachnick & Fidell, 2013). As such, through exploratory factor analyses, the ESE-E demonstrated a 7-factor solution with 64.3% of variance explained. Factors included *product ideation, business planning, customer discovery, team and network formation, idea pitch, people and human resources,* and *finance.* See Table 1 for the detailed factor structure and factor loadings.

Such a factor structure is consistent with the Entrepreneurship Knowledge Inventory (Besterfield-Sacre et al., 2012), the original ESE instrument (McGee et al., 2009), and the specific entrepreneurship content taught to engineering students in the entrepreneurship program at the university. Additionally, correlational analyses demonstrated that these seven factors positively related to each other. This means that if students are confident about one entrepreneurial-related skill described in this instrument, they are likely to feel confident about other entrepreneurial-related skills described in the instrument.

Table 1. Factor structure of the ESE-E.

Factor	**Item (factor loading)**	**Cronbach's α**
Product ideation	1. Brainstorm a new idea for a product or service. (0.68) 2. Identify the need for a new product or service by interviewing people. (0.75) 3. Identify the need for a new product or service by using data and evidence. (0.61) 4. Use multiple sources of information to validate your idea. (0.41) 7. Talk to your potential customers about your idea. (0.36)**	.82
Business planning	9. Identify appropriate channels to get your product/ service to your customers. (0.59) 10. Estimate customer demand for a new product or service. (0.50) 11. Determine a competitive price for a new product or service. (0.84) 12. Estimate the amount of start-up funds and working capital necessary to start my business. (0.59)	.87

	13. Design an effective marketing/ advertising campaign for a new product or service. (0.60) 14. Use the business model canvas to plan out your business. (0.51)	
Customer discovery	15. Create a startup thesis and generate hypotheses. (0.54)* 16. Use scientific methods (e.g., run experiments) to test your business hypotheses. (0.58) 17. Create a minimum viable product to learn about the market. (0.65) 18. Use various resources to overcome obstacles in your business. (0.59) 19. Pivot or make major changes to your business model. (0.57)*	.87
Team and network formation	5. Identify partners and form a team. (0.65) 6. Justify whether you need co-founders. (0.53) 20. Get others to identify with and believe in my vision and plans for a new business. (0.53) 21. Network – i.e., make contact with and exchange information with others. (0.58)	.80
Idea pitch	8. Use everyday terms to introduce your idea to potential customers. (0.65) 22. Clearly and concisely explain verbally/in writing my business idea in everyday terms. (0.90) 23. Pitch your ideas to potential investors. (0.63)	.81
People and human resources	24. Supervise employees. (0.80) 25. Recruit and hire employees. (0.75) 26. Delegate tasks and responsibilities to employees in my business. (0.77) 27. Deal effectively with day-to-day problems and crises. (0.73) 28. Inspire, encourage, and motivate my employees. (0.61) 29. Train employees. (0.65)	.91

Finance	30. Organize and maintain the financial records of my business. (0.54) 31. Manage the financial assets of my business. (1.01) 32. Read and interpret financial statements. (0.62)	.87

Note: *cross loading; **factor loading is less than 0.4.

Research Question 2: Are students' creative mindsets related to their entrepreneurial self-efficacy?

Overall, students demonstrated moderately high self-efficacy in the subscales, a high growth creative mindset, and a low fixed creative mindset. Table 2 displays the descriptive results of the ESE-E and the creative mindsets.

Table 2. Descriptive statistics

	Product Ideation	Team & Network Formation	Idea Pitch	Business Planning	Customer Discovery	People & Human Resources	Finance	Growth Creative Mindset	Fixed Creative Mindset
Valid	96	96	96	96	96	95	95	96	96
Mean	390.75	282.82	223.56	335.58	358.44	419.11	172.92	17.05	9.98
Std. Deviation	67.02	73.36	52.97	110.85	89.36	111.10	70.40	2.35	2.97
Minimum	201.00	30.00	82.00	60.00	103.00	166.00	18.00	12.00	5.00
Maximum	500.00	400.00	300.00	600.00	500.00	600.00	300.00	20.00	20.00

Further, we conducted correlation analyses using Spearman's correlation tests to examine the relations between students' creative mindsets and their entrepreneurial self-efficacy. Table 3 displays the correlation results. Specifically, students with a growth creative mindset tended to have high self-efficacy in product ideation, team and network formation, and people and human resources. This indicated that students who believed they could learn to be creative were likely confident about certain entrepreneurial skills (i.e., product ideation, team and network formation, and people and human resources). In terms of the fixed creative mindset, it was negatively related to students' self-efficacy in business planning. This indicated that students who believed that one's creativity was not malleable tended to have low confidence in business planning. Additionally, all subscales were interrelated.

Table 3. Spearman's correlations.

Variable		PI	TF	IP	BP	CD	HR	FN	GM	FM
1. PI	Spearman's rho	—								
	p-value	—								
2. TF	Spearman's rho	0.616	—							
	p-value	< .001	—							
3. IP	Spearman's rho	0.565	0.583	—						
	p-value	< .001	< .001	—						
4. BP	Spearman's rho	0.484	0.633	0.483	—					
	p-value	< .001	< .001	< .001	—					
5. CD	Spearman's rho	0.688	0.710	0.602	0.600	—				
	p-value	< .001	< .001	< .001	< .001	—				
6. HR	Spearman's rho	0.495	0.608	0.497	0.582	0.596	—			
	p-value	< .001	< .001	< .001	< .001	< .001	—			
7. FN	Spearman's rho	0.310	0.521	0.420	0.626	0.549	0.599	—		
	p-value	0.002	< .001	< .001	< .001	< .001	< .001	—		
8. GM	Spearman's rho	0.299	0.227	0.122	0.079	0.100	0.205	0.034	—	
	p-value	0.003	0.026	0.236	0.441	0.333	0.046	0.741	—	
9. FM	Spearman's rho	-0.007	-0.014	-0.011	0.247	-0.049	-0.051	0.142	-0.322	—
	p-value	0.948	0.890	0.918	0.015	0.636	0.621	0.169	0.001	—

Note. PI = Product ideation; TF = Team & network formation; IP = Idea pitch; BP = Business planning; CD = Customer discovery; HR = People/Human resources; FN = Finance; GM = Growth creative mindset; FM = Fixed creative mindset.

Research Question 3: How reliable are the Entrepreneurial Self-Efficacy for Engineering Students (ESE-E) scales?

To address this research question, we examined the internal consistency reliability of the ESE-E scales. Internal consistency reliability refers to an approach to estimating the test score reliability in a set of items as a group (Gall et al., 2007). Because the scores of the ESE-E items were continuous ranging from 0 to 100, we used Cronbach's Alpha to calculate the reliability. Specifically, Cronbach's α was .95 across all the items of the ESE-E. In addition, each subscale demonstrated good internal reliability (Cronbach's $\alpha > .80$). According to Nunnally and Bernstein (1994), this demonstrated excellent internal reliability of the ESE-E.

Limitations and future directions

The present study contributed an appropriate instrument for measuring engineering students' entrepreneurial self-efficacy to the literature. However, we acknowledge the limitations of the current study. For example, we had two items that were cross-loaded and needed to continue testing and modifying the items. Given that we are still in the early stage of instrument development, we had a limited sample size to conduct more advanced data analyses to further validate the instrument, such as confirmatory factor analyses. In future studies, we hope to recruit a larger sample size from our university and entrepreneurship education programs in other

universities to examine whether the instrument is appropriate for other programs and student populations.

References

American Educational Research Association, American Psychological Association, & National Council on Measurement in Education (2014). *Standards for educational and psychological testing.* Washington, DC: Joint Committee on Standards for Educational and Psychological Testing.

Anna, A., Chandler, G., Jansen, E., & Mero, N. (1999). Women business owners in traditional and nontraditional industries. *Journal of Business Venturing, 15*(3), 279–303.

Asimakopoulos, G., Hernández, V., & Peña Miguel, J. (2019). Entrepreneurial intention of engineering students: The role of social norms and entrepreneurial self-efficacy. Sustainability, 11(16), 4314.

Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of Social and Clinical Psychology, 4*(3), 359-373.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191–215.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* Freeman

Bandura, A. (2006). Guide for constructing self-efficacy scales. *Self-efficacy Beliefs of Adolescents, 5*(1), 307-337.

Barbosa, S., Gerhardt, M., & Kickul, J. (2007). The role of cognitive style and risk preference on entrepreneurial self-efficacy and entrepreneurial intentions. *Journal of Leadership & Organizational Studies, 13*(4), 86–104.

Besterfield-Sacre, M., Zappe, S., Shartrand, A., & Hochstedt, K. (2016). Faculty and Student Perceptions of the Content of Entrepreneurship Courses in Engineering Education. *Advances in Engineering Education, 5*(1), n1.

Chen, G.C., Greene, P.G., & Crick, A. (1998). Does entrepreneurial self-efficacy distinguish entrepreneurs from managers. *Journal of Business Venturing, 13*, 295–317.

Cropley, D. H. (2016). *Creativity in engineering* (pp. 155-173). Springer Singapore.

Da Silva, G. B., Costa, H. G., & De Barros, M. D. (2015). Entrepreneurship in engineering education: A literature review. *International Journal of Engineering Education, 31*(6), 1701-1710.

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). *Educational research: An introduction* (8th edition). Pearson.

Shekhar, P., & Huang-Saad, A. (2021). Examining engineering students' participation in entrepreneurship education programs: implications for practice. International Journal of STEM Education, 8, 1-15.

JASP Team (2023). JASP (Version 0.17.1) [Computer software].

Kaiser, H. F. (1974). An Index of Factorial Simplicity. *Psychometrika, 39*, 31-36.

Karwowski, M. (2014). Creative mindsets: Measurement, correlates, consequences. *Psychology of Aesthetics, Creativity, and the Arts, 8*(1), 62.

Krueger, N.F., Reilly, M.D., & Carsrud, A.L. (2000). Competing models of entrepreneurial intentions. *Journal of Business Venturing, 15*, 411–432.

McGee, J. E., Peterson, M., Mueller, S. L., & Sequeira, J. M. (2009). Entrepreneurial self–efficacy: Refining the measure. *Entrepreneurship Theory and Practice, 33*(4), 965-988.

Messick, S. (1995). Standards of validity and the validity of standards in performance assessment. *Educational Measurement: Issues and Practice, 14*(4), 5-8.

Nunnally J. C., & Bernstein I. H. (1994). *Psychometric theory*. (3rd ed.). McGraw-Hill Inc.

Schunk, D. H. (1989). Self-efficacy and achievement behaviors. *Educational Psychology Review, 1*, 173-208.

Sun, T., Wang, C., & Kim, S. Y. (2022). Psychometric properties of an English Writing Self-Efficacy scale: aspects of construct validity. *Reading and Writing*, *35*(3), 743-766.

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2013). *Using multivariate statistics* (Vol. 6, pp. 497-516). Pearson.

Varier, D., Kitsantas, A., Zhang, X., & Saroughi, M. (2021). Self-efficacy for self-assessment: Development and validation of the SEESA-AW scale for argumentative writing. *International Journal of Educational Research*, *110*, 101885.

Walton, A. P. (2003). The impact of interpersonal factors on creativity. *International Journal of Entrepreneurial Behavior & Research, 9*(4), 146-162.

Wang, E. L., & Kleppe, J. A. (2001). Teaching invention, innovation, and entrepreneurship in engineering. *Journal of Engineering Education, 90*(4), 565-570.

Zappe, S. E., Cutler, S. L., & Gase, L. (2023). A Systematic Review of the Impacts of Entrepreneurial Support Programs in Science, Technology, Engineering, and Math Fields. *Entrepreneurship Education and Pedagogy, 6*(1), 3-31.

Appendix. Selected Items of the ESE Scales by McGee et al. (2009)

Searching

How confident are you that you can…

1. Brainstorm (come up with) a new idea for a product or service.
2. Identify the need for a new product or service.
3. Design a product or service that will satisfy customer needs and wants.

Planning

4. Estimate customer demand for a new product or service.
5. Determine a competitive price for a new product or service.
6. Estimate the amount of start-up funds and working capital necessary to start my business.
7. Design an effective marketing/ advertising campaign for a new product or service.

Marshaling

8. Get others to identity with and believe in my vision and plans for a new business.
9. Network – i.e., make contact with and exchange information with others.
10. Clearly and concisely explain verbally/in writing my business idea in everyday terms.