Using Entrepreneurial Mindset Constructs to Compare Engineering Students and Entrepreneurs

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Abstract

Current efforts to transform engineering education vary in their intensity and direction. One area that has gained considerable momentum in recent years is the effort to promote development of an entrepreneurial mindset (EM) in undergraduate engineering students. A driving force behind this momentum is the Kern Entrepreneurial Engineering Network (KEEN). KEEN is a group of over 40 institutions united in the mission to promote entrepreneurial-minded learning in engineering students. In KEEN, EM is construed to have three primary components, the 3C's of Curiosity: Connection; and Creating Value. Recent efforts within the network led to the development of the Engineering Student Entrepreneurial Mindset Assessment (ESEMA) instrument as a tool to understand EM development within students. The ESEMA operationalizes EM measurement through a 34-item survey. These items load on six factors of interest: ideation, open-mindedness, interest, altruism, empathy, and help seeking.

This work investigates how measurement of these factors compare between engineering students and working entrepreneurs. Data were collected using an instance of the ESEMA and several other instruments hosted in Qualtrics at Montana State University (MSU). The sample includes 397 responses from junior and senior engineering students at MSU. Qualtrics Research Services was utilized to collect complete responses from 172 working professionals. These professionals self-identified as entrepreneurs during survey screening questions. Comparisons between the two groups were made across all six ESEMA factors and a number of other measures using t-tests in R. These comparisons found statistically significant differences ($\alpha \leq 0.1$) between the groups in five of the six ESEMA factors. Moreover, regression results showed students having lower Entrepreneurial Intent and lower probability of starting a business while in college even after controlling for all six ESEMA factors. While additional investigation is warranted, these stark differences should raise questions for engineering educators interested in promoting entrepreneurial minded learning. Specifically, if the ESEMA outcomes are aligned with promoting the development of future entrepreneurs, are we taking the right actions to develop this mindset?

Introduction

For decades leaders in academia, industry, and government have recognized the need for engineering education to develop engineers who are more than simply technical experts [e.g. 1, 2, 3]. The responses of the engineering education community to meet those needs are widespread and varied in their approaches. Results have also been varied [4, 5]. In recent years, a notable workstream has grown around development of engineering entrepreneurship. One specific area that is receiving increased attention from engineering educators and engineering education researchers is the development of an entrepreneurial mindset within engineering students.

This increased focus on entrepreneurial mindset is being accelerated by the support of the Kern Family Foundation and their Kern Entrepreneurial Engineering Network (KEEN). KEEN is a growing network, currently approaching 50 institutions, of U.S. engineering programs who conceptualize entrepreneurial mindset (EM) as consisting of three components referred to as the 3Cs [6]. Those components are summarized as:

- Curiosity – seeking information about our changing world and exploring contrarian views of accepted solutions.
- Connection – integrating varied sources and perspectives to gain insight.
- Creating Value – placing engineering work in the context of societal needs and working through failure to see those needs met.

While EM has been conceptualized and measured in various ways [7], due to the growing importance of KEEN in engineering education, this work utilizes the 3Cs conceptualization as measured by the Engineering Student Entrepreneurial Mindset Assessment (EMSEA) [8].

Given the attention that entrepreneurial minded learning (EML) is receiving in engineering education and the mixed results of previous efforts to refine engineering education, we should be curious about the effects of EML on students with regard to entrepreneurship. To that end, this work investigates the alignment of EM between engineering students at Montana State University (MSU) and working professionals who identify themselves as entrepreneurs, hereafter referred to as "working entrepreneurs." This investigation seeks to answer the following five research questions:

RQ1. How do upper division engineering students compare to working entrepreneurs on measures of Entrepreneurial Mindset? (mindset comparison)

RQ2. How do these students compare to working entrepreneurs on measures of Entrepreneurial Intent and the probability of starting a business in college? (intent comparison)

RQ3. How do these students compare to working entrepreneurs on measures of Emotional Intelligence? (EI comparison)

RQ4. How do these students compare to working entrepreneurs on measures of Grit? (Grit comparison)

RQ5. How do measures of Grit, Entrepreneurial Mindset, Emotional Intelligence and participant demographics correlate with students' measures of Entrepreneurial Intent? (predicting intent)

This work utilized a quantitative research approach to answer these questions.

Entrepreneurship and Engineering Students

The growing interest in promoting EML in engineering students is also driving a growing literature in this area. These studies range in their focus, but many are concerned with understanding the relationship between EML (or entrepreneurship in general) and other, more familiar, areas of the engineering education literature. These include explorations of the relationship to "makers" behavior [9], how various experiences can promote EML (e.g. first year [10] and extra-curricular [11]), and applications in specific courses, both traditional engineering [12] and those with a more specific EML focus [13].

Outside of these more application-oriented areas, there have been workshops to contextualize what entrepreneurial education should look like in engineering [14], comparisons between engineering and business students' interest in entrepreneurship [15], and exploration of the predictors of entrepreneurial self-efficacy [16]. In addition, there is a rapidly growing literature examining the development of instruments to measure various conceptualizations of entrepreneurial mindset in engineering students [8, 17-21]. What seems to be lacking in any of these studies is an investigation of the alignment between these measures and the mindset of practicing entrepreneurs. This work seeks to begin closing that gap.

Data Collection Methods

Data for this study was collected using the Qualtrics online survey tools hosted by MSU. The data was collected in two distinct phases, one for students and one for working entrepreneurs, using previously published and validated instruments to understand EM, Grit, Emotional Intelligence, Entrepreneurial Intent, and the probability of starting a business in college. The details of these methods are discussed in the following sections.

Instruments

To obtain a more complete picture of the relationship between EM as conceptualized by members of the KEEN network and other measures commonly found to relate to entrepreneurship in the literature, this study deployed an electronic survey that consisted of four previously published and validated instruments. These instruments provide measures of EM, Grit, Emotional Intelligence, Entrepreneurial Intention, and Entrepreneurial Engagement.

As mentioned above, the EM instrument utilized was the ESEMA [8, 17]. The ESEMA is a fairly broad measure of EM that has been refined over time and subjected to validation tests. An example item is "I believe it is important I do things that fix problems in the world." The instrument loads on the following factors:

- **Altruism**: a four-item scale measuring interest in making a positive contribution to the world
- **Empathy**: a three-item scale that measures the appreciation of others' perspectives and viewpoints.
- **Help Seeking**: a five-item scale measuring willingness to seek out help when necessary.
- **Ideation**: eleven items that measure enjoyment in generating ideas and challenging the status quo and one item that measures persistence through setbacks.
- **Interest (engagement)**: a three-item scale that measures an inherent interest in a range of activities.
- **Open-Mindedness**: an eight-item scale that measures the appreciation of, and willingness to work with, individuals with different expertise.

This instrument utilizes a five-point Likert type scale ranging from "Never or Rarely True of Me" to "Always or Almost Always True of Me" with a midpoint of "True of Me About Half the Time."

To measure Grit, this study used Duckworth and Quinn's 12-item scale [22]. "I have achieved a goal that took years of work" is an example item from this instrument. Overall, the instrument consists of two subscales:

- **Consistency:** concerned with one's passion for ideas or goals
- **Perseverance**: measuring attributes like tenacity, hard work, diligence, and finishing whatever one begins.

Items on this instrument are measured on traditional five-point Likert scale from "Strongly Disagree" to "Strongly Agree."

To measure Emotional Intelligence, this work utilized the instrument developed by Wong and Law [23]. This instrument utilizes 18 items to measure four constructs. An example item is "I have a good sense of why I have certain feelings most of the time." The four constructs are:

- **Self-Emotion Appraisal (SEA)**: measuring understanding of one's own emotions.
- **Others' Emotion Appraisal (OEA)**: measuring understanding of the emotions of others.
- **Use of Emotion (UOE)**: measuring perception of self in a positive or negative manner.
- **Regulation of Emotion (ROE)**: measuring ability to control emotions.

Items in this instrument are measured on seven-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree."

To measure Entrepreneurial Intent, this study utilized a five item scale from the work of Gelhof and colleagues [24]. These items focused primarily on the creating of new ventures or organizations with one item exploring the importance of changing an existing entity, more akin to common conceptualizations of intrapreneurship. These items are measured on a five-point Likert scale from "Not at all important" to "Extremely Important." To measure Entrepreneurial Engagement, students and working entrepreneurs were asked if they started a business when in college.

Collection of Student Data

A cross-sectional data set of student responses using these instruments were collected at MSU during the fall of 2019. Participation was gained by attending 14 different courses and allowing students the time needed to complete the surveys while in class. Participants included students from three different colleges (Arts and Architecture, Business, and Engineering) at all class years. For the purpose of this work, we limited responses to only juniors and seniors in engineering whose responses did not fail screening procedures designed to remove incomplete or inaccurate responses. This resulted in 397 student responses which were used for the analysis in this study.

Collection of Entrepreneur Data

Data on working professionals were collected using an online convenience sample of 220 surveys consisting of participants who self-identified as entrepreneurs using Qualtrics panel definitions. Panel members were compensated by Qualtrics for participating in the survey. In addition to the instruments described above, participants were asked to provide descriptive statistics for age, gender, years of work experience, hours of work per week, and where they live

(urban, small city, small town, rural). Following data cleaning procedures designed to remove incomplete or fabricated responses, a total of 172 responses were included in this comparison group for further analysis.

Analysis Procedures

Once data cleaning procedures were completed, data were analyzed using a number of procedures in the R statistical software environment. To answer the question comparing mindset (RQ1), quantitative measures of each factor in the ESEMA were developed for both the student and working entrepreneur groups. The measures for each group were then compared using t-tests. Answering questions comparing intent (RQ2), emotional intelligence (RQ3), and Grit (RQ4) followed similar procedures, first building scores of the Entrepreneurial Intent, Emotional Intelligence, and Grit constructs and then comparing them using t-tests.

Analysis to answer the question of predicting intent (RQ5) required more complex analysis. First scores for all instrument measures were collected. These measures were combined with the measures calculated for the other instruments and information on participant demographics into an Ordered Logit Regression model for overall Entrepreneurial Intent and a Logit Regression model for whether the respondent started a business while in college. Each individual regressor was then reviewed for its contribution to elements of intent or engagement. Regressors included all elements of the instruments described above, a flag for student or entrepreneur, gender, and prior exposure to entrepreneurs through a family member. Figure 1 provides a graphical overview of the two models.

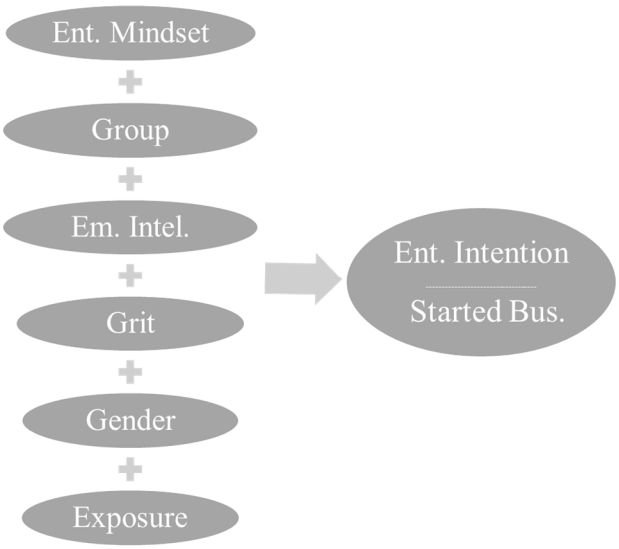

Figure 1 - Overview of Regression Model Components

Results

The analysis of the data found statistically significant differences under each of the five research questions. For Research Question 1, Table 1 provides the comparison of the mindset elements measured by the ESMEA, scaled 1 – 5, between engineering students and working entrepreneurs. As shown in the table, there are significant differences between students and working entrepreneurs on five of the six dimensions measured. Students scored significantly higher on Altruism and Open Mindedness, while entrepreneurs scored higher on empathy, help seeking, and ideation.

Table 1 - Comparison of Students and Entrepreneurs on Five Point ESEMA Scales

EM Dimension	Students	Entrepreneurs	p-Value
Altruism*	3.91	3.75	0.085
Empathy***	3.58	3.88	0.001
Help Seeking*	3.37	3.55	0.057
Ideation**	3.21	3.37	0.035
Interest	3.50	3.51	0.888
Open Mindedness***	4.38	3.92	0.000

* $\alpha < 0.1$, ** $\alpha < 0.05$, *** $\alpha < 0.01$

Analysis used to answer Research Question 2 found significant differences between students and entrepreneurs in measures of Entrepreneurial Intent and Engagement, with working entrepreneurs scoring higher on key measures ($\alpha \leq 0.01$). Table 2 summarizes these differences.

Table 2 - Students vs. Entrepreneurs - Starting a Business (%) and Entrepreneurial Intent

Ent. Intent Dimension	Students	Entrepreneurs	p-Value
Started a Business***	22%	79%	0.000
Overall Ent. Intent***	3.46	3.76	0.000
Q1: Start a Business***	3.28	4.03	0.000
Q2: Develop my own business***	3.36	4.12	0.000
Q3: Start a new organization***	3.17	3.78	0.000
Q4: Be part of a team that starts a new business	3.53	3.65	0.249
Q5: Change the way a business or organization runs	3.80	3.73	0.444

* $\alpha < 0.1$, ** $\alpha < 0.05$, *** $\alpha < 0.01$

Analysis of the components of Emotional Intelligence (RQ3) and Grit (RQ4) also found significant differences between engineering students and working entrepreneurs. Within the components of Emotional Intelligence constructs, entrepreneurs scored significantly higher ($\alpha \leq 0.1$) on their ability to understand the emotions of others (OEA) while students scored

significantly higher on their ability to regulate emotion (ROE). As summarized in Table 3, all other measures of emotional intelligence showed no significant difference between the groups. Within the Grit measures, entrepreneurs scored significantly higher ($\alpha \leq 0.1$) than students on perseverance, while no difference was found in measures of consistency. Table 4 summarizes these comparisons.

Table 3 - Comparison of Students and Entrepreneurs on Seven Point Emotional Intelligence Scales

Emotional Intelligence	Students	Entrepreneurs	p-Value
Overall	5.42	5.53	0.237
Self-Emotion (SEA)	5.34	5.5	0.223
Others' Emotion (OEA)*	5.29	5.5	0.076
Use of Emotion (UOE)	5.54	5.72	0.102
Regulate Emotion (ROE)**	5.60	5.41	0.040

* $\alpha < 0.1$, ** $\alpha < 0.05$, *** $\alpha < 0.01$

Table 4 - Comparison of Students and Entrepreneurs on Five Point Grit Scales

Grit Dimension	Students	Entrepreneurs	p-Value
Consistency	2.71	2.76	0.539
Perseverance*	3.92	4.03	0.079

* $\alpha < 0.1$, ** $\alpha < 0.05$, *** $\alpha < 0.01$

Utilizing the regression model represented in Figure 1 found a number of significant independent variables that correlated with both dependent variables (entrepreneurial intent and starting a business in college) . The results reported in Table 5 show that students have significantly lower entrepreneurial intent and engagement ($\alpha \leq 0.01$) even after controlling for EM, EI, Grit, entrepreneurial exposure, and gender. Additionally, the ordered logit model of Entrepreneurial Intention shows that only three of the components of Entrepreneurial Mindset measured by the ESEMA had a significant positive impact: Altruism ($\alpha \leq 0.01$); Help Seeking ($\alpha \leq 0.05$); and Ideation ($\alpha \leq 0.01$). Identifying as a male ($\alpha \leq 0.5$), higher Emotional Intelligence ($\alpha \leq 0.1$), and Grit: Perseverance ($\alpha \leq 0.01$) are also significantly and positively correlated with Entrepreneurial Intention. However, Grit: Consistency shows a significant negative correlation ($\alpha \leq 0.05$).

The logit model for starting a business while in college finds a different mix of significant variables. Within the ESEMA, only Empathy has a significant positive correlation ($\alpha \leq 0.05$) while surprisingly Open Mindedness has a significant negative correlation ($\alpha \leq 0.01$) with a probability of starting a business in college. The only other significant variable was exposure to entrepreneurship through a family member.

In order to explore these relationships more deeply for engineering students (RQ4), additional models were built for both dependent variables that included the eleven interactions between student and the other variables of interest (e.g. student x altruism, student x emotional

intelligence). These models found only a single interaction (student x interest) had a positive significant correlation with starting a business ($\alpha \leq 0.1$).

Table 5 – Coefficients of Models for Students' Entrepreneurial Intention and Starting a Business

	Entrepreneurial Intention				Starting a Business		
Variable	**Coefficient**	**p-Value**			**Coefficient**	**p-Value**	
Students	-0.74	0.00	***		-2.47	0.00	***
EM: Altruism	0.35	0.01	***		0.00	0.98	
EM: Empathy	0.18	0.13			0.38	0.02	**
EM: Help Seeking	0.24	0.02	**		0.02	0.89	
EM: Ideation	0.66	0.00	***		0.21	0.35	
EM: Interest	0.10	0.31			-0.04	0.81	
EM: Open Mindedness	-0.25	0.12			-0.59	0.01	***
Male	0.47	0.02	**		0.28	0.34	
Ent. Exposure	-0.14	0.43			0.58	0.02	**
Emotional Intelligence	0.25	0.08	*		-0.08	0.68	
Grit: Consistency	-0.25	0.04	**		-0.16	0.36	
Grit: Perseverance	0.73	0.00	***		-0.05	0.87	

* $\alpha < 0.1$, ** $\alpha < 0.05$, *** $\alpha < 0.01$

Implications

There are a number of implications from this work for engineering educators working to promote Entrepreneurial Minded Learning. The stark differences between engineering students and working entrepreneurs on ESEMA measures points to potential focus areas for engineering educators. Specifically, methods to promote student development of empathy, help seeking behaviors, and ideation appear to be needed. These exact areas of EM, in which students scored significantly lower than entrepreneurs, are positively correlated with Entrepreneurial Intention and Engagement. Additionally, cultivating entrepreneurial interest in engineering students (enjoying, participating, and being involved in a variety of activities) maybe the most fruitful way to see more engineering students pursuing entrepreneurship in the future.

However, those comparisons do not appear to provide the full picture. Comparing the ESEMA elements with measures of Entrepreneurial Intent and Engagement brings the utility of the ESEMA into question. Specifically, assuming a desirable outcome of EML is developing engineering graduates who are likely to pursue entrepreneurship in the future, the findings in this work indicate a limited relationship between the ESEMA elements and those outcomes. First, not all elements of EM were significantly correlated with Entrepreneurial Intention and Engagement. Second, Open Mindedness was negatively correlated with both outcomes (and highly significant with the probability of starting a business). Finally, and most importantly, even after controlling for all ESEMA elements, engineering students scored significantly lower on Entrepreneurial Intention and Engagement suggesting that there are other very significant factors leading to these outcomes that are not captured by the ESEMA.

It is also worth mentioning that Grit: Perseverance (tenacity, hard work, diligence, and finishing whatever one begins) was significantly correlated with Entrepreneurial Intention and engineering students were found to have significantly lower levels of this type of Grit compared to working entrepreneurs. Thus, developing perseverance in students may provide a fruitful focus area for engineering educators interested in promoting Entrepreneurial Intention.

Limitations

While this study made many efforts to gather a robust sample, students were only drawn from a single R1 university with a large engineering presence. The authors make no claims that these students would be representative of a national sample that included a greater diversity of institution types. In addition, while the sample of working entrepreneurs drawn through Qualtrics is similar to the methods used widely in the literature, the nature of responses raised some concerns. Specifically, concerns that respondents were gaming the system to meet the qualification criteria and receive their payment led to elimination of over 20% of responses. Proposed approaches to further alleviate this concern are discussed in plans for future research.

Conclusion and Direction for Future Research

This study represents the beginning of a multi-year effort to understand and improve EML across the Norm Asbjornson College of Engineering, Jake Jabs College of Business and Entrepreneurship, and the College of Arts and Architecture at Montana State University. While it provides interesting insight into the similarities and differences between engineering students and working entrepreneurs, it has also raised questions about how EM is assessed within engineering students and the alignment between these assessments and desirable educational outcomes for engineering students. Future work will employ mixed methods research to better understand the relationship between measures of EM and entrepreneurial activity and intentions. Specifically, a longitudinal study is being deployed to understand changes in EM over the duration of student experiences across the three colleges at MSU. In addition, qualitative interviews will provide insight into how students construe EM and its relationship to entrepreneurial intent. This insight will enable educators to make research driven changes to their programs to promote greater levels of entrepreneurial activity within their students. That work will support efforts to measure the effectiveness of promoting EML in the classroom.

Acknowledgements

This material is based in part upon work of the authors through the author's work with the Kern Entrepreneurial Engineering Network (KEEN). For more information and additional shared content, go to EngineeringUnleashed.com.

References

[1] National Research Council, *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*. The National Academies Press, 2005.

[2] E. Dowell, E. Baum, and J. McTague, "The green report: engineering education for a changing world," American Society for Engineerig Education, 1994. [Online]. Available: https://www.asee.org/papers-and-publications/publications/The-Green-Report.pdf

[3] American Society for Engineering Education, "Transforming Undergraduate Education in Engineering: Phase I: Synthesizing and Integrating Industry Perspectives - Workshop Report," National Science Foundation, Washington, DC, 2013.

[4] L. J. Shuman, M. Besterfield-Sacre, and J. McGourty, "The ABET "Professional Skills" - Can They Be Taught? Can They Be Assessed?," *Journal of Engineering Education,* vol. 94, no. 1, pp. 41-55, 2005.

[5] L. Deslauriers, L. S. McCarty, K. Miller, K. Callaghan, and G. Kestin, "Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom," *Proceedings of the National Academy of Sciences,* vol. 116, no. 39, pp. 19251-19257, 2019.

[6] Kern Family Foundation. "What is Entrepreneurial Mindset?" https://engineeringunleashed.com/mindset-matters.aspx (accessed 2020).

[7] C. Naumann, "Entrepreneurial mindset: A synthetic literature review," *Entrepreneurial Business and Economics Review,* vol. 5, no. 3, pp. 149-172, 2017.

[8] S. R. Brunhaver, J. M. Bekki, A. R. Carberry, J. S. London, and A. F. McKenna, "Development of the Engineering Student Entrepreneurial Mindset Assessment (ESEMA)," *Advances in Engineering Education,* vol. 7, no. 1, p. n1, 2018.

[9] M. J. Mabey, S. S. Jordan, M. Lande, and S. Weiner, "A Comparison of Maker and Entrepreneurial Characteristics," presented at the ASEE Annual Conference and Expositon, Columbus, Ohio, 2017/06/24, 2017. [Online]. Available: https://peer.asee.org/27454.

[10] N. R. Sattele, K. M. Kecskemety, and K. A. A. Parris, "Analysis of the Entrepreneurial Mind-set Elements in Established First-year Engineering Labs: Analysis Process and Lessons Learned and Changes for the Future," presented at the ASEE Annual Conference and Exposition, Tampa, Florida, 2019/06/15, 2019. [Online]. Available: https://peer.asee.org/32089.

[11] C. Q. Li, R. Harichandran, S., N. O. Erdil, M.-I. Carnasciali, and J. Nocito-Gobel, "Assessing the Growth in Entrepreneurial Mind-set Acquired through Curricular and Extra-curricular Components," presented at the first year experiences Tampa, Florida, 2019/06/15, 2019. [Online]. Available: https://peer.asee.org/31905.

[12] J. Baqersad, Y. Dong, A. Mazzei, A. Sheidaei, and B. Alzahabi, "Implementation of an Innovation and Entrepreneur Mindset Concept into Mechanics of Materials Course," presented at the ASEE Conference and Exhibition, Salt Lake City, Utah, 2018/06/23, 2018. [Online]. Available: https://peer.asee.org/30614.

[13] P. Shekhar, A. Huang-Saad, J. Libarkin, R. Cummings, and V. Tafurt, "Assessment of Student Learning in an Entrepreneurship Practicum Course," presented at the ASEE Conference and Exhibition, Columbus, Ohio, 2017/06/24, 2017. [Online]. Available: https://peer.asee.org/27639.

[14] S. D. Sheppard *et al.*, "Exploring What We Don't Know About Entrepreneurship Education for Engineers," presented at the ASEE Conference and Exhibition, Seattle, Washington, 2015/06/14, 2015. [Online]. Available: https://peer.asee.org/24083.

[15] Q. Jin, S. K. Gilmartin, S. D. Sheppard, and H. L. Chen, "Comparing engineering and business undergraduate students' entrepreneurial interests and characteristics," *The Journal of Engineering Entrepreneurship,* vol. 6, no. 2, pp. 1-24, 2015.

[16] P. Shekhar, A. Huang-Saad, J. Libarkin, and A. K. Ostrowski, "'Is Someone in Your Family an Entrepreneur?': Examining the Influence of Family Role Models on Students' Entrepreneurial Self-efficacy and its Variation Across Gender," presented at the ASEE Annual Conference and Exposition, Salt Lake City, Utah, 2018/06/23, 2018. [Online]. Available: https://peer.asee.org/29647.

[17] J. S. London, J. M. Bekki, S. R. Brunhaver, A. R. Carberry, and A. F. McKenna, "A Framework for Entrepreneurial Mindsets and Behaviors in Undergraduate Engineering Students: Operationalizing the Kern Family Foundation's" 3Cs"," *Advances in Engineering Education,* vol. 7, no. 1, p. n1, 2018.

[18] R. Harichandran, S. , N. O. Erdil, M.-I. Carnasciali, C. Q. Li, J. Nocito-Gobel, and A. Rana, "EML Indices to Assess Student Learning through Integrated e-Learning Modules," presented at the ASEE Annual Conference and Exhibition, Tampa, Florida, 2019/06/15, 2019. [Online]. Available: https://peer.asee.org/32704.

[19] T. P. James, C. G. Downing, and D. Evans, "Comparison of Two Survey Instruments for the Assessment of Entrepreneurial Mindset," presented at the ASEE Annual Conference and Exhibition, Columbus, Ohio, 2017/06/24, 2017. [Online]. Available: https://peer.asee.org/28057.

[20] T. M. Fernandez, G. S. Coutinho, M. D. Wilson, and S. R. Hoffmann, "Development of Entrepreneurial Attitudes Assessment Instrument for Freshman Students," presented at the ASEE Annual Conference and Exhibition, Seattle, Washington, 2015/06/14, 2015. [Online]. Available: https://peer.asee.org/23874.

[21] T. M. Fernandez and N. Duval-Couetil, "Exploring Ways to Measure Entrepreneurial Mindset: The development of a Student-Focused Effectual Logic Assessment Instrument," presented at the ASEE Annual Conference and Exhibition, Columbus, Ohio, 2017/06/24, 2017. [Online]. Available: https://peer.asee.org/28344.

[22] A. L. Duckworth and P. D. Quinn, "Development and validation of the Short Grit Scale (GRIT–S)," *Journal of personality assessment,* vol. 91, no. 2, pp. 166-174, 2009.

[23] C.-S. Wong and K. S. Law, "The effects of leader and follower emotional intelligence on performance and attitude: An exploratory study," *The leadership quarterly,* vol. 13, no. 3, pp. 243-274, 2002.

[24] G. J. Geldhof, M. Weiner, J. P. Agans, M. K. Mueller, and R. M. Lerner, "Understanding entrepreneurial intent in late adolescence: The role of intentional self-regulation and innovation," *Journal of youth and adolescence,* vol. 43, no. 1, pp. 81-91, 2014.