Work-In-Progress: A Mixed Method Longitudinal Study to Assess Mindset Development in an Entrepreneurial Engineering Curriculum

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A Mixed-Method Longitudinal Study of Entrepreneurial Mindset in an Entrepreneurial Engineering Curriculum

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Abstract

For many years, Lawrence Technological University has been engaged in a campus-wide effort to instill an entrepreneurial mindset (EM) in our engineering undergraduates. As part of this effort, we have intentionally created opportunities at all levels of our curriculum for students to practice an enterprising attitude. This entrepreneurial experience begins in the freshman year with EGE 1001: Intro to Engineering Design Projects in which students are introduced to the engineering design process through collaborative, team-based design projects, and entrepreneurial attributes, such as tolerance for ambiguity and social awareness. In the sophomore-level course EGE 2123: Entrepreneurial Engineering Design Studio, students build upon this foundation of entrepreneurially-minded learning (EML) through a semester-long team design project where students identify opportunities for design within a theme, engage real customers outside the classroom, and design and build a working prototype that creates value for these customers. At the junior level, students continue to expand upon their EM through project-based learning in multiple discipline-specific courses. Leadership, teamwork, and ethics are also explored in an interdisciplinary, active and collaborative learning- based course. Finally, this entrepreneurial thread culminates in the senior capstone experience in which students apply their engineering skill set while exercising their EM in a year-long, real-world design project.

This paper describes the work done to determine the effect of the EM-focused engineering curriculum sequence on developing the entrepreneurially-minded engineer. While multiple methods were used to assess EM in a sample of undergraduate students, the bulk of this work focuses on the data collected from the Entrepreneurial Minded Learning (EML) survey, an original forced-choice rapid self-report questionnaire administered throughout the curriculum. The EML survey measured three dimensions of EM: Curiosity, Connections, and Creating Value. Students also participated in open-ended interview responses regarding their EM. Finally, students were directly assessed on EM via performance on a problem-based case study. Results describe the psychometric properties of the EML survey, the longitudinal growth of EM across the four-year curriculum, and tests of the effect of the curriculum on the development of EM. Recommendations for EM curriculum development within engineering programs are presented, as well as recommendations for future research opportunities.

Introduction

At its conception during the turbulent economic times of the Great Depression, Lawrence Technological University, founded in 1932 as Lawrence Institute of Technology, was established when the demand for innovative thinkers possessing a sound technical skill set was paramount to drive the new technical era into a reality. The Lawrence brothers, Russell and E. George, had the vision to develop future leaders of industry by preparing its students through an educational philosophy dedicated to 'theory and practice'. With its rich history and through the guidance of many generations of university leaders – from presidents to provosts to deans – Lawrence Tech continues to develop leaders through innovative and agile programs embracing theory and practice [1].

Kern Entrepreneurial Engineering Network (KEEN) and the Entrepreneurial Mindset

Dedication to preparing future leaders and innovators in engineering who have an EM was substantiated through Lawrence Tech's partnership with the Kern Family Foundation. The Kern Family Foundation was founded with the belief that, to meet the needs of an ever-changing global marketplace, engineering education must evolve to develop entrepreneurial-minded engineers that possess the requisite technical skills but also leverage those skills to both recognize and fulfill unmet customer needs. In 2004, LTU became a KEEN partner with other universities having the shared mission of transforming undergraduate engineering education. Through granting financial support dedicated to training faculty in entrepreneurially-minded teaching pedagogies, curriculum modification, and facilitating collaborations with like-minded institutions, KEEN works to enable the development of engineers that, along with their technical skillset, exhibit an EM. Why is this mindset so valuable in engineering education?

Much like during the generation of the Lawrence brothers, it is today's engineers with an enterprising attitude that will make their impact on the world by investigating it with an insatiable curiosity and by integrating their discoveries with their own knowledge and experiences to develop truly innovative solutions that meet the needs of a rapidly changing world [2]. The KEEN framework [3] serves to describe the behaviors associated with an EM. This framework has evolved over time and now categorizes both student outcomes and example behaviors with the 3 C's: curiosity, connections, and creating value. Engineering undergraduates demonstrating each of these 3 C's are said to exhibit an EM.

Entrepreneurial Engineering Curriculum Thread at Lawrence Tech

Since joining KEEN, a campus-wide effort to instill an EM in our undergraduates has been focused on three initiatives: faculty engagement, curriculum development and student engagement. The focus of the assessment work presented herein is to report on the efficacy of the program resulting from the more-than-decade-long effort to develop the entrepreneurially minded engineer.

Within the College of Engineering, the thread of EML at Lawrence Tech is characterized as the Interdisciplinary Design & Entrepreneurial Application Sequence, or IDEAS. Individual engineering programs were given the option to incorporate all or portions of IDEAS into their curriculum based on their current curriculum content. IDEAS is further defined below relative to class and participating engineering programs.

Freshman Year – Aiming to instill the EM, our undergraduate engineering curricula engages students in a first-year course that embeds entrepreneurial skills with design and project work. Architectural, biomedical, civil, computer, electrical, embedded software, industrial, mechanical and robotics engineering students participate in the first year course, EGE 1001: Fundamentals of Engineering Design Projects. This course lays the foundation for EM development within the curriculum. EGE 1001 is a multidisciplinary course that serves to introduce first year students to the role of the engineer in society and the engineering design process by engaging in multiple short-term projects within one semester. The projects introduce basic engineering concepts while instilling EM attributes and behaviors such as: effective communication, teamwork, ethics and ethical decision-making, customer awareness, innovation, time management, critical thinking, global awareness, self-directed research, life-long learning, learning through failure, tolerance for ambiguity, and estimation [4].

Sophomore Year - Most EM-focused programs employ the first year and senior capstone/project experiences. The hallmark of IDEAS is the sophomore level course, EGE 2123: Entrepreneurial Engineering Design Studio. In this second year course, students continue to develop an EM by working in multidisciplinary teams on a semester-long design project. Biomedical, civil, industrial, and mechanical engineering students engage with a real-world customer outside the classroom and then identify an opportunity for design within a design theme. Student teams utilize outcome-driven innovation methods to gather focused customer feedback that allow them to develop both an understanding of the motivations and perspectives of others and gain insight into how to create value based on customer needs [2]. A heavy emphasis is placed on communicating with the customer throughout the design process through both oral presentations and through building multiple levels of prototypes to represent their design concepts. It is this build-to-learn approach that informs the design decisions that must be made in order to manage and assess risk as well as realize the design that will best create value for the customer. Throughout the semester, teams must manage a long-term project and account for economic and market viability of their project. Finally, student teams design, build, and test a final working prototype that is then delivered to the customer.

Junior Year - The majority of the junior year is spent accumulating knowledge and technical skills in discipline-specific coursework. EML is delivered in the form of discipline-specific projects that incorporate problem-based or project-based learning. Students in most engineering programs will experience multiple EML modified courses. Since the spring of 2019, EGE 3022: Leadership and Professional Development for Engineers is a required course of all engineering undergraduates. In this multidisciplinary course, students study and apply leadership, ethics, teamwork, and professional development skills relevant to engineering. The course introduces students to frameworks for various leadership concepts and ethical decision-making in personal, professional, and organizational settings.

Senior Year – Senior/capstone projects provide all engineering students with the opportunity to solve real-world, open-ended engineering projects that bring together students' technical skillset and their EM. Much of the professional skills that are cultivated throughout IDEAS: oral and written communication, ideation and innovation, sustainability, customer awareness and value, technical feasibility, societal benefits, and economic analysis, are addressed with increasing depth in the capstone experience.

At the culmination of this entrepreneurially-minded curriculum thread, our engineering undergraduates have been afforded multiple opportunities at all levels of the curriculum to practice and grow their EM as they build their technical skillset.

Assessment Methods and Results

In order to determine the effect of the EM-focused IDEAS curriculum sequence on developing the entrepreneurially-minded engineering student, a comprehensive repeated cross-sectional study design was employed to gather and analyze data from engineering students throughout the curriculum. This comprehensive data collection and analysis plan was needed due to the evolution of the original KEEN framework to the 3 C's framework over the past decade – in essence, a moving target for assessment work.[1] Therefore, for this study, multiple measures were used to assess over time a broad depiction of student characteristics specifically linked to the 3 C's. The intent of the study was two-fold: to demonstrate the efficacy of the program, and to identify student- or program-level strengths and weaknesses with regard to EM development of students as they progress through the engineering curriculum [5]. This study utilized two indirect assessment methods (self-report surveys and student interviews) and one direct assessment method. The tools were administered to freshmen, sophomores, juniors, and seniors as listed in Table 1.

Indirect Assessment Instruments

Indirect assessment of EM involves a variety of data collection instruments, including self-report questionnaires and interviews designed to measure specific operationally defined constructs by asking respondents to estimate their level of agreement to a variety of questions (usually clustered into multiple dimensions), on attitudes, beliefs, knowledge, learning experiences, opinions, thoughts, and values [5] [6]. For the present study, we developed the Entrepreneurial Minded Learning (EML) survey. The EML survey measures three dimensions of EM: curiosity, connections, and creating value. Students also provided open-ended interview responses regarding their EM. As each of these tools relies on students to self-assess their own perceived EM, these represent indirect assessments used to gather student feedback on their experiences or attitudes about their learning experiences. Although indirect methods of assessment may be used to provide feedback from students, these methods were used in the present study to complement the findings of direct assessment by providing more context to students' learning [5].

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[1] Currently, a KEEN subnet is developing an assessment protocol. See https://engineeringunleashed.com/subnets/subnetview.aspx?GroupGuid=a36b2628-d4a1-4f30-930b-957b780b4d52

Table 1: Assessment Timeline

Assessment/ Class	Fall 2015	Fall 2016	Spring 2017	Fall 2017	Spring 2018	Fall 2018	Spring 2019	Fall 2019
INDIRECT ASSESSMENTS								
Entrepreneurial Minded Learning (EML) Surveys								
Freshmen				X				
Sophomores (no EGE 2123)+				X				
Sophomores (pre EGE 2123)++		X	X					
Sophomores (post EGE 2123)+++		X	X					
Juniors					X		X	
Seniors							X	
Student Interviews*								
Freshmen	X	X						
Sophomores		X		X				
Juniors				X		X		
Seniors						X		X
DIRECT ASSESSMENTS								
Freshman (no EGE 2123)				X				
Sophomores (no EGE 2123)				X				
Sophomores (completed EGE 2123)				X				
Juniors (no EGE 2123)				X				
Juniors (completed EGE 2123)				X				
Seniors (no EGE 2123)				X				
Seniors (completed EGE 2123)				X				

Note. +These students did not take EGE 2123. ++Given to students enrolled in EGE 2123 at the beginning of the semester. +++Given to the same students at the end of the semester. *Face-to-face interviews were conducted with the same students each fall throughout their four-year program.

1. Entrepreneurial Minded Learning (EML) Surveys - The EML survey was created at Lawrence Technological University with the intent of having students across the four-year curriculum self-assess their EM on 29 questions rated along a 5-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). Originally, the 29 questions were clustered into four dimensions (5-8 questions per dimension): Problem Solving and Critical Thinking, Teamwork, Business Acumen, and Societal Issues. The EML survey was created prior to the development of the KEEN 3 C's. Therefore, best practices in survey development (e.g., exploratory and confirmatory factor analysis) were employed to identify a set of 9 questions that best encapsulate the meaning behind the 3C's: Curiosity (3 questions), Connections (3 questions), and Creating Value (3 questions). Students were administered the EML surveys via paper-and-pencil as listed in Table 1. The results are comprised of an EM total score and three subscale scores (see Table 3).

As shown in Table 2, data were collected from 486 engineering students across the curriculum:

- Freshman, n = 53, 11%
- Sophomore, n = 255, 52%
- Junior, n = 100, 21%
- Senior, n = 78, 16%

Table 2 also shows the distribution of students across their engineering programs:

- Biomedical Engineering, n = 85, 17.5%
- Civil Engineering, n = 55, 11.3%
- Computer Engineering, n = 8, 1.6%
- Industrial Engineering, n = 10, 2.1%
- Mechanical Engineering, n = 328, n = 67.5%

Table 2: Frequency Distribution of Study Participants

	Freshman		**Sophomore**		**Junior**		**Senior**		**Total**	
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Total Sample	53	100.0	255	100.0	100	100.0	78	100.0	486	100.0
Program										
Biomedical Eng.	4	7.5	52	20.4	11	11.0	18	23.1	85	17.5
Civil Eng.	10	18.9	17	6.7	10	10.0	18	23.1	55	11.3
Computer Eng.	4	7.5	1	0.4	1	1.0	2	2.5	8	1.6
Industrial Eng.	2	3.8	8	3.1	0	0.0	0	0.0	10	2.1
Mechanical Eng.	33	62.3	177	69.4	78	78.0	40	51.3	328	67.5

Note. Sample frequency is expressed as % of all participants, n = 486.

The psychometric properties of the EML survey were evaluated in the study sample using Cronbach's coefficient alpha test of internal consistency reliability [7], tested via SPSS V26, and confirmatory factor analysis (CFA) test of construct validity [8], tested via M*plus* 8.4.

In evaluating reliability of the study measures, scales with alphas ≥ 0.7 are considered reliable [21]. To evaluate construct validity, four goodness of fit indices (GFIs) were used: Chi-square, root mean square error of approximation (RMSEA), comparative fit index (CFI), and factor loadings. Several researchers have suggested the following goodness of fit indices (GFI) criteria for acceptable construct validity using CFA: ratio of Chi-square to the degrees of freedom (df) ≤ 2, RMSEA < 0.08, CFI ≥ 0.90, and factor loadings significant at $p < 0.05$ [9], [10], [8].

As shown in Table 3, the EM full scale and each of the three subscales were found to be reliable in the study sample (alpha > 0.7). Results of the CFA found all GFIs support construct validity for the EML survey: Chi-square/df = 1.59, RMSEA = 0.035, CFI = 0.983, and all factor loadings were significant at p < 0.001. The factorial structure of the EML survey with standardized factorial loadings is shown in Figure 1. Taken together, these results support that the EML survey is a reliable and valid measure.

Table 3: Psychometric Properties of the Entrepreneurial Mindset Scale

Survey Items	**Mean[1]**	**SD[2]**	**Alpha[3]**	**Factor[4]**
EM Full Scale - 9 items	4.16	0.41	0.769	--
Curiosity (CUR)	4.08	0.49	0.729	0.760
cur1. Devise multiple solutions	4.05	0.66	--	0.598
cur2. Gain new information	4.25	0.63	--	0.496
cur3. Think outside the box	3.96	0.74	--	0.654
Connections (CON)	4.18	0.50	0.706	0.918
con1. Understand feelings and motives of others	4.20	0.65	--	0.583
con2. Know when to lead or follow	4.07	0.76	--	0.414
con3. Develop and maintain working relationships	4.26	0.65	--	0.525
Creating Value (CV)	4.23	0.58	0.717	0.815
cv1. Serve the needs of others	4.18	0.73	--	0.655
cv2. Make environmentally sensitive decisions	4.02	0.82	--	0.646
cv3. Make a positive impact on society	4.48	0.63	--	0.741

Note. Psychometric properties conducted on survey data from n = 486 study participants. Tests of model fit for confirmatory factor analysis (CFA): Chi-square = 34.89, $df = 22$, $p = .04$; RMSEA (90% CI) = 0.035 (0.008-0.056); CFI = 0.983.[1]Mean of items within scale measured on a 5-point Likert scale, 1 = strongly disagree, 5 = strongly agree. [2]Standard deviation. [3]Cronbach's alpha reliability measure of internal consistency. [4]Standardized factor loading scores from CFA significant at $p < 0.001$.

ANOVA (conducted in SPSS V26) was used to test for significant differences in the EM total score and the CUR, CON, and CV subscale scores across the four levels of students and their programs at the 95% level of significance (see Table 4). As shown in Figure 1, significant differences in the mean EM total score was found between freshmen and seniors, and between freshman and sophomores, with sophomores and seniors scoring significantly higher than freshman at the 95% level of significance ($p < 0.05$). Seniors also scored significantly higher than freshman in the CUR subscale, and sophomores scored significantly higher than freshman in the CV subscale. Across programs, biomedical engineering students scored significantly higher than civil engineering students in the mean EM and CV scores, and industrial engineering students scored significantly higher than civil, computer and mechanical engineering students.

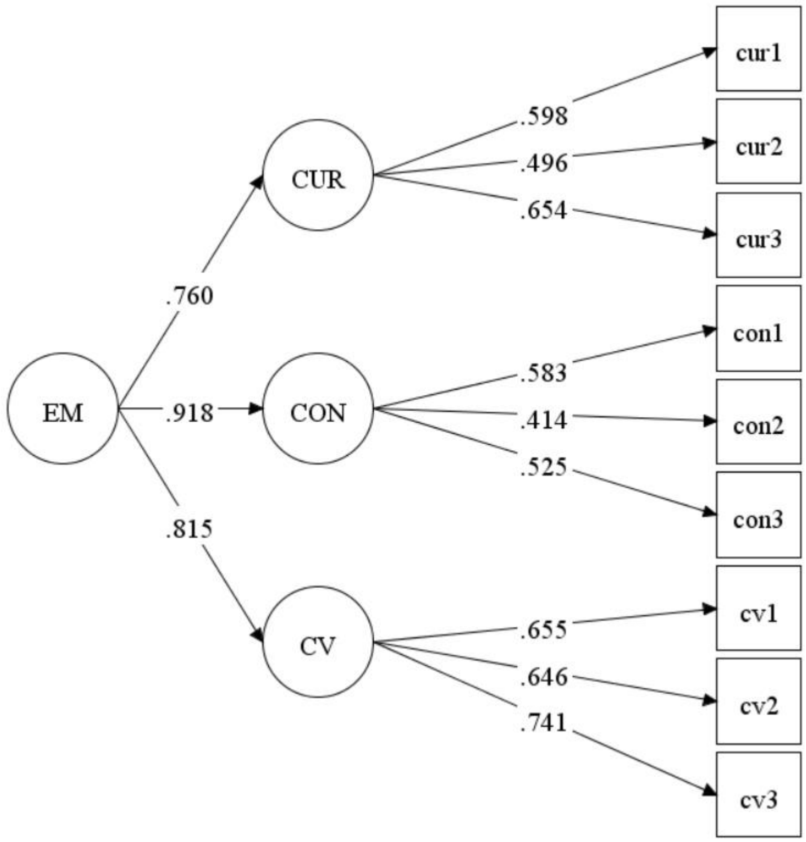

Figure 1: Factorial structure of the EML survey

Table 4: Mean and SD of EM Across Demographic Characteristics

Characteristic	EM		CUR		CON		CV	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Total Sample	4.16	0.41	4.08	0.49	4.18	0.50	4.23	0.58
Level								
Freshman	4.03*	0.38	3.97*	0.53	4.09	0.44	4.03*	0.62
Sophomore	4.19	0.40	4.09	0.48	4.17	0.50	4.30	0.53
Junior	4.14	0.42	4.07	0.44	4.18	0.51	4.16	0.62
Senior	4.21	0.45	4.15	0.56	4.26	0.52	4.21	0.62
Program								
Biomedical Eng.	4.31*	0.42	4.17	0.52	4.32	0.49	4.45*	0.54
Civil Eng.	4.05	0.45	3.96	0.56	4.15	0.47	4.03	0.64
Computer Eng.	4.07	0.48	3.96	0.45	4.04	0.60	4.21	0.62
Industrial Eng.	4.24	0.28	4.00	0.38	4.17	0.59	4.57	0.32
Mechanical Eng.	4.14	0.40	4.09	0.47	4.15	0.50	4.19	0.57

Note. Descriptive statistic are mean and standard deviation (SD) across level. $^*p < 0.05$ significant difference between mean scores within level and program according to one-way ANOVA (N = 486).

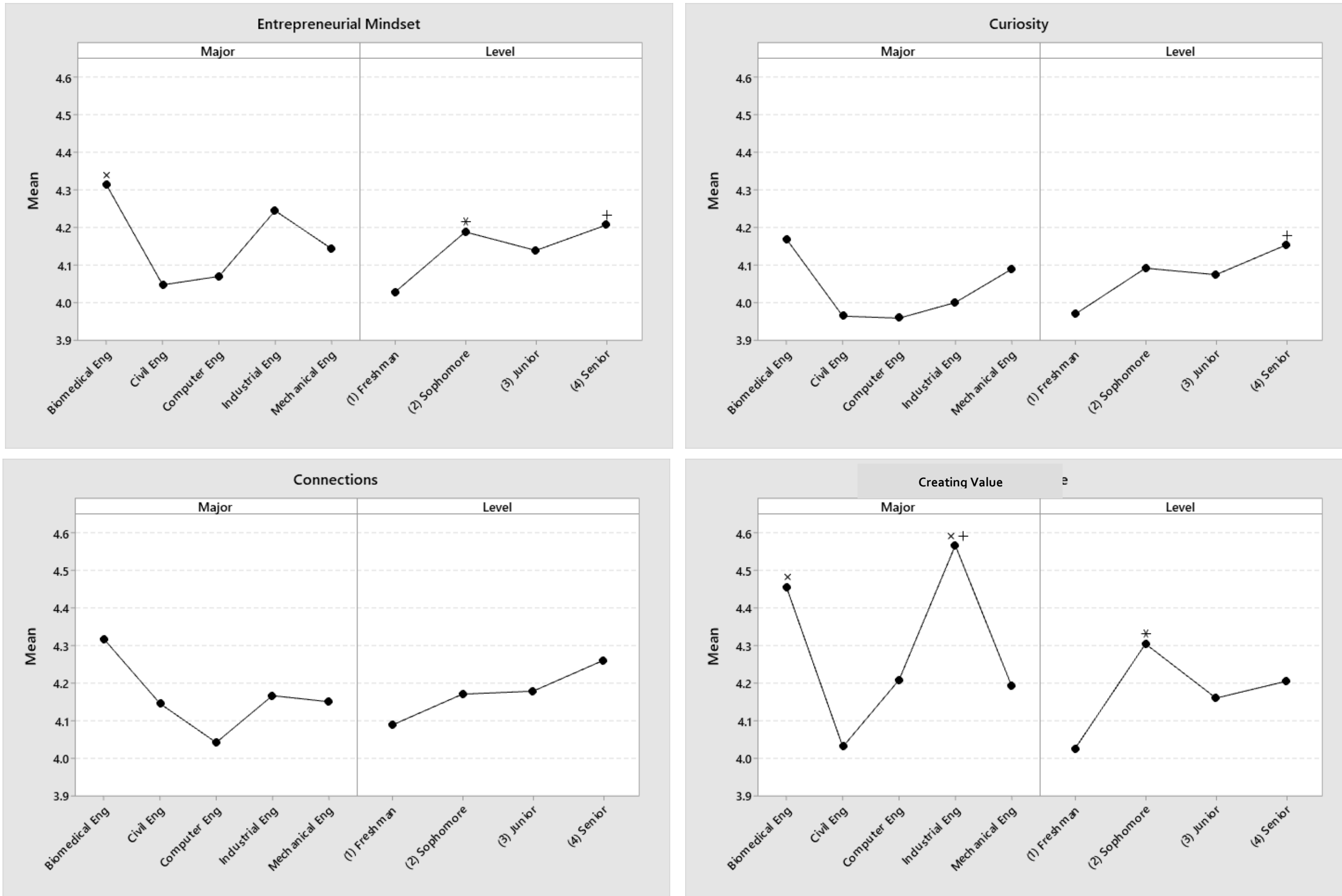

Figure 2: Plot of EM scores across students. $^{*}p < 0.05$ *significant difference between freshman and sophomore.* $^{+}p < 0.05$ *significant difference between freshman and senior.* $^{x}p < 0.05$ *significant difference between Biomedical Engineering and Civil Engineering.* $^{x+}p < 0.05$ *significant difference between Industrial Engineering and Civil Engineering.*

Table 5: EML t-Test Results in Sophomores Enrolled in EGE 2123

EM	N	Mean	Diff	SEM	*T*	*df*	*p*
Pre	150	4.13	0.19**	0.03	3.70	180	<0.001
Post	87	4.33	--	0.04	--	--	--
cur							
Pre	150	4.01	0.23**	0.04	3.42	180	<0.001
Post	87	4.24	--	0.06	--	--	--
con							
Pre	150	4.12	0.20**	0.04	3.01	180	0.003
Post	87	4.31	--	0.05	--	--	--
cv							
Pre	150	4.27	0.15**	0.04	2.20	180	0.029
Post	87	4.42	--	0.05	--	--	--

Note. T-test comparing differences in mean EM total scores and the subscales CUR, CON, and CV between sophomores at the beginning of the semester (Pre) and at the end of the semester (Post). SEM = standard error of the mean, Diff = Post-Pre difference score. (SD) across level. $^{**}p < 0.01$ significant Post-Pre difference according to independent samples *t-test.*

In addition to assessing EM development at the program level, the EML survey was administered at the beginning (Pre) and at the end of the semester (Post) of EGE 2123 (Table 1) as a course-level assessment tool. Pre-Post differences in mean EM total and subscale scores were tested via independent sample t-tests. As shown in Table 5, the Pre-Post differences were significant for the EM total score and the CUR, CON, and CV subscale scores.

2. Student Interviews - This second indirect assessment instrument tracked two cohorts of approximately 15 undergraduate engineering students each over the course of four years.[2] These students were volunteers who participated in videotaped interviews where they were asked a set of scripted, open-ended interview questions. The questions were developed to allow the students to reveal their views on their personal educational experiences. Students were also asked to provide a list of various attributes affiliated with the EM and their development through the curriculum. A thematic analysis was used to identify common EM themes across students. Results found the following themes with highest frequency across students: business owner, change agent, communication, creativity, ideas, independence, innovative, persistence, and risk taker.

Direct Assessment Instrument

In this mixed-method study, a direct assessment instrument was created to lend validity to the interpretation of student self-reported opinions and perceptions as inferred from analysis of the above-described indirect assessment tools. Differences in performance between students participating in the IDEAS curriculum and those who did not fully participate were analyzed via *t*-tests.

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[2] These cohorts did undergo attrition each year.

Instructors used an analytic rubric derived from the KEEN framework and scored student behavior on an entrepreneurially-themed case study from the Higher Education Website. This case study [11] illustrates elements of entrepreneurship in engineering and traces the start-up of a company providing mountain bike parts launched by two engineering graduates that are concurrently undertaking PhD research. The rubric was used to score student performance on the case study in five outcomes along a 4-point scale (1 = Not Evident, 2 = Emerging, 3 = Developing, and 4 = Mastering): (1) Define problems, opportunities, and solutions in terms of value creation; (2) Assess risk; (3) Anticipate technical developments by interpreting surrounding societal and economic trends; (4) Ask questions to determine customer needs; and (5) Evaluate business opportunities. Sum scores on the direct assessment can range from 5-20.

Students who did and who did not participate in course EGE 2123 (Table 1) were administered the case study which required each student to read four outcome-driven, open-ended scenarios and submit an essay-style response to a/the prompt(s) relating to each scenario. Prompts were carefully constructed to minimize the influence on students' responses. Student responses to each scenario were then scored in two phases: (1) independent scoring by two instructors using the direct assessment rubric, and (2) consensus scoring via instructor discussion.

As shown in Table 6, both sophomores and juniors who participated in EGE 2123 scored significantly higher on the case-study compared to students who did not.

Table 6: Direct Assessment t-Test Results for Sophomores and Juniors

Class	N	SUM	Diff	*T*	*df*	*p*
Sophomores						
No EGE 2123	18	8.72	3.62**	11.38	44	<0.001
Yes EGE 2123	44	12.34	--	--	--	--
Juniors						
No EGE 2123	9	8.56	3.61**	4.78	8	0.001
Yes EGE 2123	12	12.17	--	--	--	--

Note. T-test comparing differences in total score on a case-study direct assessment scored using a 4-point rubric (the rubric measured five outcomes) between students with EGE 2123 (Yes) and those without EGE 2123 (No). Diff = Yes-No difference score. $^{**}p < 0.01$ significant Yes-No difference according to independent samples *t*-test.

Conclusion and Future Work

With the support of KEEN, LTU has developed and implemented an entrepreneurially-minded curriculum over the past decade. Through IDEAS, the objective is to develop the entrepreneurial engineer. Having both the first year and senior capstone/project experiences that many EM-focused programs employ, the hallmark of IDEAS is the sophomore level entrepreneurial engineering design studio - EGE 2123. Through this semester long team-based multidisciplinary design course, students exercise their EM in the context of real-world problems which they identify and develop solutions for through interacting with real customers.

Assessment of EM is challenging. This study reports on the development and application of a comprehensive EM assessment methodology. Repeated cross-sectional samples of students across a four-year EM-focused curriculum and a mixed-method protocol combining quantitative and qualitative data were utilized. Quantitative data were collected from among a sample of 486 engineering students via the EML survey and an analytic rubric; qualitative interview data were collected from a sample of 30 students. Data were repeatedly collected throughout the curriculum to obtain a longitudinal analysis. Data were analyzed using inferential statistics (ANOVA, independent samples *t*-test) and thematic analysis to quantify the impact of IDEAS on student EM in terms of the following pertinent findings:

- The EML survey is a reliable and valid measure of EM in terms of curiosity (CUR), connections (CON), and creating value (CV).
- Seniors in the IDEAS curriculum have significantly higher EM and CUR scores than freshmen, and sophomores have significantly higher EM and CV scores than freshmen.
- EM and CV scores differ across programs.
- Among sophomores in EGE 2123, post-course EM, CUR, CON, and CV scores were significantly higher than pre-course scores.
- Among sophomores and juniors, students in the IDEAS curriculum have significantly higher scores on an EM performance rubric than those who are not in the curriculum.
- Students in the IDEAS curriculum express an EM in terms of Business Owner, Change Agent, Communication, Creativity, Ideas, Independence, Innovative, Persistence, and Risk Taker.

Taken together, these results suggest participating in the four-year EM-focused IDEAS curriculum increases EM over the course of the curriculum, with some programs having higher EM than others. Results also suggest participation in the IDEAS curriculum has significant effect on student entrepreneurial-minded behavior.

Future work is necessary to understand why there are differences in EM and CV scores across the engineering programs. Future work is also necessary to correlate EML survey scores with performance rubric scores in the same sample of students to determine the predictive validity of the EML survey. Finally, future work should continue to triangulate multiple sources of data on EM, including use of focus groups as a source of qualitative data.

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