2017

Curriculum Innovation: Incorporating the Kern Engineering Entrepreneurial Network (KEEN) Framework into Online Discussions

Lisa Bosman
Marquette University

Brooke Mayer
Marquette University, Brooke.Mayer@marquette.edu

Patrick J. McNamara
Marquette University, patrick.mcnamara@marquette.edu

Promoting Entreprenuerially Minded Learning through Online Discussions

Dr. Lisa Bosman, Marquette University

Dr. Lisa Bosman holds a PhD in Industrial Engineering from the University of Wisconsin – Milwaukee. Her research interests include solar energy performance modeling, entrepreneurial minded learning, and STEM education.

Dr. Brooke K. Mayer, Marquette University
Prof. Patrick McNamara, Marquette University

Dr. McNamara is beginning his 4th year as an assistant professor at Marquette University. His research group focuses on understanding how consumer product chemicals impact microbes and antibiotic resistance in treatment plants. Additionally his group researches non-traditional treatment processes to remove these chemicals from water. Prior to Marquette, Dr. McNamara earned his PhD in Civil Engineering from the University of Minnesota in 2012 and his MS in Environmental Engineering from the University of Texas in 2008. In 2006 he earned a BS in Civil Engineering from Marquette University. More information on his research group can be found at: http://mcnamaraenviro.wix.com/research

Curriculum Innovation: Incorporating the Kern Engineering Entrepreneurial Network (KEEN) Framework into Online Discussions

Lisa Bosman[1], Brooke Mayer[1], and Patrick McNamara[1]

[1]Marquette University, Opus College of Engineering, Milwaukee, Wisconsin, USA
{lisa.bosman, brooke.mayer, patrick.mcnamara}@marquette.edu

Abstract: The purpose of this study was to respond to the following research question: How does the Kern Engineering Entrepreneurial Network (KEEN) framework build interest in technical topic areas, impact student learning outcomes, and develop the entrepreneurial mindset when applied to the engineering classroom? The KEEN framework was developed to combine the entrepreneurial mindset with engineering education to produce a more valuable, strategically prepared engineer, rather than simply an "obedient engineer". The framework proposes that the entrepreneurial mindset of students is increased by promoting curiosity, encouraging connections, and creating value. The results from this work provide insight into the impact and implications resulting from applying the KEEN framework to the engineering classroom via online discussions.

Keywords: writing, journals, reflections, assessment, KEEN, curiosity, connections, creating value.

1 Introduction

The entrepreneurial mindset is a "growth-oriented perspective through which individuals promote flexibility, creativity, continuous innovation, and renewal" [1]. While the entrepreneurial mindset can be useful in starting a new company, this mindset is also critical to existing organizations to ensure competitiveness and survival. In recent years, the entrepreneurial mindset has increasingly been recognized as important within the engineering arena [2]. Engineers need to design new products and services with a focus on the value proposition and user needs, and not simply based on technical and functional concepts taught in the traditional engineering classroom. A recent survey of engineering students found two-thirds of the students thought entrepreneurship education could broaden their career prospects and choices [3].

In Spring 2015, the researchers collected survey data from 363 students, 21 engineering faculty, and 19 industry representatives asking respondents about the benefit and need for incorporating the entrepreneurial mindset into the engineering curriculum. The survey required participants to consider what types of entrepreneurially-minded skills employers are seeking, in addition to what types of entrepreneurial-minded skills participants would like to see taught in engineering classrooms. Additionally, in Spring 2016, the researchers completed a student focus group with 7 university engineering students. The purpose of the focus group was to gauge student interest in, and understanding of, the entrepreneurial mindset, identify current barriers to getting students engaged in entrepreneurially-minded activities and events, and to determine how to best create

awareness of the entrepreneurial mindset for students. The survey and focus group results provided evidence of the need to increase incorporation of the entrepreneurial mindset in the engineering classroom at every level, not simply within the capstone senior design courses.

Due to the relative ease in implementation, a group of lead faculty determined that online class discussions (either through an online class or face-to-face class) would provide an ideal starting point for incorporating the entrepreneurial mindset. Creating, deploying, and managing an online discussion can be accomplished effectively and efficiently with a relatively minor investment in prep work prior to deploying the online discussion [12-14] with limited classroom disruption. Furthermore, online discussions provide many benefits for both face-to-face classrooms and online courses [9-11]. First, they afford students the necessary time to provide a thought provoking response and to consider other potential research or recent news media to support their responses. Second, they provide students the opportunity to read and gain insight from other students' posts. Finally, they give instructors the chance to provide immediate student feedback and ask further questions to dig deeper into the subject at hand.

Several frameworks exist which consider the behaviors, skills, or attributes driving an individual's entrepreneurial mindset. The Innovator's DNA, a 6 year study analyzing entrepreneurs and executives [4], suggested that the most innovative entrepreneurs exhibit skills including associating, questioning, observing, experimenting, and networking. The Entrepreneurial Strengthsfinder framework stems from years of Gallup research [5] and determined that select personality traits drive entrepreneurs to success: independent, creative thinker, promoter, knowledge-seeker, determination, confidence, risk-taker, relationship-builder, business focus, and delegator. Based on empirical research, the Entrepreneurial Orientation framework[6, 7] determined three critical characteristics for entrepreneurial mindsets: pro-activeness, [calculated] risk-taking, and innovativeness. The book, "Teaching Entrepreneurship: A Practice Based Approach" [8], applies anecdotal evidence and years of experience training entrepreneurship educators to posit that entrepreneurial orientation stems from practicing the following skills: empathy, play, reflection, experimentation, and creation. Similarly, the Kern Entrepreneurial Engineering Network (KEEN) also took an anecdotal approach to propose the 3C's of the entrepreneurial mindset: (1) **Curiosity -** Demonstrate constant curiosity about our changing world. Explore a contrarian view of accepted solutions. (2) **Connections** - Integrate information from many sources to gain insight. Assess and manage risk. (3) **Creating Value -** Identify unexpected opportunities to create extraordinary value. Persist through and learn from failure.

The KEEN framework is specifically focused on integration into undergraduate engineering education. Therefore, the purpose of this study was to respond to the following research question: How does the Kern Engineering Entrepreneurial Network (KEEN) framework build interest in technical topic areas, impact student learning outcomes, and develop the entrepreneurial mindset when applied to the engineering classroom? This study provides insight into how to create and deploy an online discussion grounded in KEEN's 3C's, using the example of an Environmental Engineering class.

2 Methods

Two different types of data analysis were employed with different intentions in mind. First, secondary data analysis allowed the researchers to investigate the influence the KEEN framework had on online discussions, with respect to *building interest in the topic area*. The secondary data included the recorded discussion conversations obtained from two different sections of a course on Introduction to Environmental Engineering. Second, the survey allowed the researchers to investigate the influence the KEEN framework had on online discussions, with respect to *impact on student learning outcomes* and the *perceived development of the entrepreneurial mindset*. A survey was deployed to obtain student perceptions of participating in KEEN-focused discussion assignments for two additional courses on Environmental Chemistry and a Seminar in Environmental Engineering. This section provides details associated with each type of data collection and analysis.

2.1 Secondary Data Collection and Analysis: Comparison of KEEN Related Student Outcomes vs. Quality of Discussion Conversation

The secondary data collection and data analysis required a three-phase approach. First, the online discussion prompts were developed with a focus on the KEEN philosophy considering the 3C's of the entrepreneurial mindset. Second, the online discussion prompts were deployed over two different semesters for the same course (Introduction to Environmental Engineering). Third, the data was collected and analyzed to better understand how the KEEN framework *builds interest in technical topic areas* when applied to the engineering classroom. This section will provide the details associated with these three phases.

Phase 1: Development of the Online Discussion Prompts

The online discussion prompts were developed for a course on Introduction to Environmental Engineering with a focus on the KEEN philosophy considering the 3C's of the entrepreneurial mindset, as shown in Table 1.

Table 1: KEEN Framework - Student Outcomes

KEEN 3C's	ID	Example Behavior
Curiosity	C1A	Demonstrate constant curiosity about our changing world
	C1B	Explore a contraraian view of accepted solutions
Connections	C2A	Integrate information from many sources to gain insight
	C2B	Assess and manage risk
Creating Value	C3A	Identify unexpected opportunities to create extraordinary value
	C3B	Persist through and learn from failure

Table 2 highlights the 6 discussion prompts developed for Introduction to Environmental Engineering. The online discussion prompts were developed by the instructor for the course, which is required for all students completing the bachelor's degree in civil engineering at Marquette University. The course provides a fundamental basis to understand and evaluate the environment and to design systems for environmental quality control.

Table 2: Discussion Prompts and Topics for Introduction to Environmental Engineering

Topic	Discussion Prompt
1. Fundamentals: Units, Materials, Balance & Kinetics	Picture the Earth several hundred years in the future. How is it different and how is it the same? What role do engineers play? What role do environmental engineers play? Do environmental engineers make a difference?
2. Environmental Chemistry: Stoichiometry & Chemical Equilibria	You may be noticing in this module that Environmental Engineering involves a lot of chemistry. For some folks this is fabulous…yea, chemistry! For others, not so much… Take a few minutes and describe how you're feeling about chemistry, i.e., is it a love-love, love-hate, or all hate relationship. Where do you get hung up? What are your concerns? What are your strong suits? What kinds of advice would you give to others who might take a more (or less) dim view of chemistry than you do?
3. Water Resources & Pollutants	Part 1: Identify the body of water (river, lake, stream, sea, ocean, etc.) you will use in the activity in this module (see instructions below). Check out the postings that have been submitted thus far and be sure to select a body of water that has not already been selected. Part 2: Are we actually running out of water or not? Take a stand and support it with explanations regarding quantity, quality, and potential stressors. Part 3: Pick one of the following proposals about alternative sources of fresh water and argue in support of or against the proposal. Be sure to do some research (online or otherwise) to gather related information and viewpoints. Describe the information you find and the potential implications of your position. Additionally, address the concerns of those who take alternate positions and suggest potentially acceptable alternatives.
4. Water Treatment	Make the case that tap water or bottled water is a better choice based on safety, taste, economics and convenience of each. To inform your discussion, take a look online for information about tap water treatment and cost and look at the labels of a couple different brands of bottled water to find out where the water comes from and how it is treated.
5. Wastewater Treatment	(1) Antibiotics, endocrine disrupting compounds (EDCs), pharmaceuticals and personal care products (PPCPs), and nanoparticles are considered emerging problems in wastewater treatment. Take a position about whether or not any or all of these are a problem. Describe what is currently being done about them, if anything. (2) Based on your understanding of these issues, do you think measures should be taken to keep them out of water environments in the first place? If so, what would you recommend? Do you think there should be greater focus on removing them from wastewater? If so, what kinds of things do you think should be done? Is this much ado about nothing?
6. Air Pollutions Sources, Stationary Sources	Research types of geoengineering being considered to address atmospheric CO2 concentrations and then present your favorite option and make a case for whether or not it should be implemented.

Phase 2: Deployment of the Online Discussion

The KEEN-focused online discussions, shown in Table 2 were deployed during the Summer 2015 and Summer 2016 semester. The same instructor taught the class, and a total of 12 students participated in the course and associated online discussions. Each discussion lasted one week, and the students were required to make an initial post and then respond to at least one other post or two other posts for summers 2016 and 2015, respectively. Additionally, the students were provided a grading rubric with clear expectations for making an initial post and responding to their peers' posts.

Phase 3: Secondary Data Collection and Analysis

The purpose of the secondary data collection and analysis was to evaluate the impact of incorporating the KEEN framework into online discussions, and the associated ability to build interest in technical topic areas. First, discussions prompts were evaluated for the level of KEEN related student outcomes. Second, each individual discussion conversation was assessed for Average Words per Student Participant, Average Words per Post, and Average Posts per Student Participant. Finally, correlation analysis was employed to compare KEEN related student outcomes to quality of discussion conversation. These steps are further explained in detail in the next section. This study will use aspects of the Linguistic Inquiry and Word Count framework to implicate online discussion word counts as a proxy for student interest in the topic area.

The Linguistic Inquiry and Word Count framework [15] was originally developed by social scientists to investigate the presence of cognitive, emotional, and structural occurrences in individual verbal and written dialogue. Many research studies have used this framework to analyze the impacts of online discussions in the educational environments. A recent study applied the framework to evaluate a web-based engineering classroom found word count to be an indicator of the relative degree of engagement [16]. Another study assessed online discussions in a computer science course; using regression and correlation analysis, they found that the number of posts responding to others correlated with project grades [17]. A researcher at Stanford [18] used the framework to analyze students working on an engineering challenge where students were required to think aloud about how to design and build a variety of mechanical and electronic devices; the results suggest that simply word counting can reflect the learner's affect, interest, and identify towards engineering.

2.2 Survey Data Collection and Analysis: Student Perceptions of the KEEN-Focused Discussion Assignment

The survey data collection and data analysis required a similar three-phase approach. First, the online discussion prompts were developed with a focus on the KEEN philosophy considering the 3C's of the entrepreneurial mindset. Second, the online discussion prompts (not shown) were deployed during one semester for two different courses (Environmental Chemistry and a Seminar in Environmental Engineering). Two different instructors taught the environmental engineering classes, and a total of 13 students participated in the courses and associated online discussions. Each discussion lasted one week, and the students were required to make an initial post and then respond to at least two other posts. The students were provided a grading rubric with clear

expectations for making an initial post and responding to their peers' posts. Third, the survey was distributed, collected, and analyzed to better understand student perceptions of how the KEEN framework *impacts student learning outcomes* and *develops the entrepreneurial mindset* when applied to the engineering classroom. The first two phases were conceptually similar to previous section on secondary data analysis, so this section will only focus on the survey delivered in Phase 3.

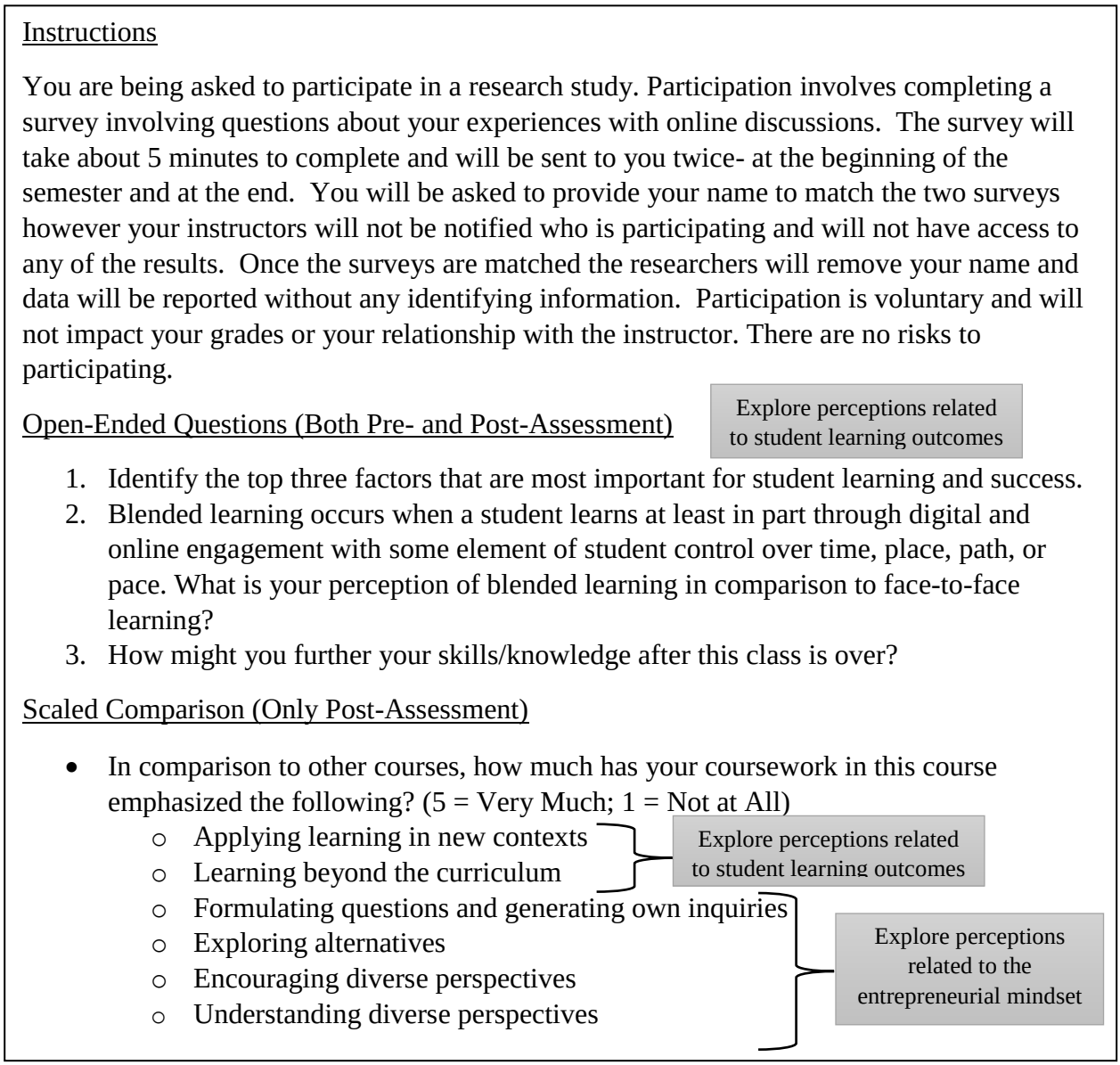

Figure 1: IRB-Approved Survey - Student Perceptions of the KEEN-Focused Discussion Assignment

The IRB-approved survey, Figure 1, included a pre- and post-assessment and aimed to better understand student perceptions of how the KEEN-focused discussion impacts student learning outcomes and develops the entrepreneurial mindset. The open-ended questions and the first two

scale questions explore student perceptions related to learning outcomes. The latter four scale questions explore student perceptions related to the entrepreneurial mindset, as defined not only by the KEEN framework but also by other typically recognized frameworks. “Formulating questions and generating own inquiries” is similar to the Innovator’s DNA [4] Questioning and Associating; the Knowledge-seeker attribute of the Entrepreneurial Strengthsfinder [5], the Reflection aspect of the “Teaching Entrepreneurship: A Practice Based Approach” [8], and promoting Curiosity within the KEEN framework. “Exploring alternatives” is similar to Experimenting in the Innovator’s DNA [4] and “Teaching Entrepreneurship: A Practice Based Approach” [8], as well as promoting Curiosity in the KEEN framework. “Encouraging and understanding diverse perspectives” comparable to Empathy in “Teaching Entrepreneurship: A Practice Based Approach” [8] and encouraging Connections in the KEEN framework.

Analysis, Results and Discussion

3.1 Secondary Data Analysis, Results and Discussion: Comparison of KEEN Related Student Outcomes vs. Quality of Discussion Conversation

First, each discussion prompt was rated by an external evaluator (a colleague of the instructor) to evaluate the quantity of KEEN related descriptors perceived to be asked within each discussion prompt. The results are shown in Table 3. For example, Discussion Prompt 1 (Fundamentals: Units, Materials, Balance & Kinetics) only promoted one KEEN related student outcome (C1A: Demonstrate constant curiosity about our changing world), and as a result, received a score of one. On the other hand, Discussion Prompt 3 (Water Resources & Pollutants) promoted five KEEN related student outcomes and received a score of 5.

Table 3: KEEN 3C Student Outcome Analysis per Discussion Prompt

	Discussion Prompt	1	2	3	4	5	6
KEEN Framework - Student Outcomes	C1A: Demonstrate constant curiosity about our changing world.	1	0	1	0	0	0
	C1B: Explore a contrarian view of accepted solutions.	0	0	1	1	1	1
	C2A: Integrate information from many sources to gain insight.	0	0	1	1	1	1
	C2B: Assess and manage risk.	0	0	1	1	1	1
	C3A: Identify unexpected opportunities to create extraordinary value.	0	0	1	0	0	0
	C3B: Persist through and learn from failure.	0	1	0	0	0	0
Total Quantity of KEEN Student Outcomes		1	1	5	3	3	3

Second, the quality of each discussion conversation was analyzed for Average Words per Student Participant, Average Words per Post, and Average Posts per Student Participant. The results, shown in Table 4, provide the data analysis for each discussion conversation. The Average Words per Student Participant for each discussion prompt varied. Discussion Prompt #3 had the highest quantity of conversation per discussion prompt and Discussion Prompt #2 had

the lowest quantity of conversation per discussion conversation. The Average Words per Post also varied. Discussion Prompt #3 had the highest average words per post for each discussion prompt and Discussion Prompt #2 had the lowest average words per post for each discussion conversation. The Average Posts per Student Participant had the least amount of variance. Discussion Prompt #6 had the highest average posts per student and Discussions Prompt #1 had the lowest average posts per student for each discussion conversation.

Table 4: Correlation Analysis

Discussion Prompt	Average Words per Student Participant	Average Words per Post	Average Posts per Student Participant	KEEN 3C Student Outcome Rating (From Table 3)
1	457.9	218.3	2.167	1
2	335.2	121.9	2.700	1
3	718.5	274.4	2.727	5
4	512.1	257.6	2.273	3
5	514.8	238.2	2.200	3
6	476.7	160.0	3.000	3
Correlation	0.913	0.655	0.287	

Third, correlation analysis was employed to compare the level of KEEN related student outcomes (From Table 3) to the quality of the discussion conversation, with respect to Average Words per Student Participant, Average Words per Post, and Average Posts per Student Participant. The results of the correlation analysis are also shown in The correlation between the KEEN 3C Student Outcome Rating (From Table 3) and the Average Words per Student Participant was 0.913. The correlation between the KEEN 3C Student Outcome Rating (From Table 3) and the Average Words per Post was 0.655. These first two correlations are not surprising: as the quantity of KEEN student outcomes increases, one might expect the quantity of discussion response to increase. The correlation between the KEEN 3C Student Outcome Rating (From Table 3) and the Average Posts per Student Participant was 0.287. It is important to keep in mind that students were only required to respond to peers one time during Summer 2015 and two times during Summer 2016. Although the correlation is relatively small, it is positive and suggests that student interest in the topic, based on the Linguistic Inquiry and Word Count framework [15], may increase as the quantity of KEEN 3C student outcomes increases.

3.2 Survey Data Analysis, Results and Discussion: Student Perceptions of the KEEN-Focused Discussion Assignment

<u>Open-Ended Questions (Pre- and Post-Assessment)</u>

1. Identify the top three factors that are most important for student learning and success.

Common responses for both pre- and post- assessment included: teacher effectiveness, student study habits, and course schedule. The response to this question did not change much from pre- to post-assessment, and as a result, offers limited insight into the research question.

2. Blended learning occurs when a student learns at least in part through digital and online engagement with some element of student control over time, place, path, or pace. What is your perception of blended learning in comparison to face-to-face learning?

The responses to this question changed quite a bit from pre- to post-assessment. In the pre-assessment, 15% of the students preferred blending learning (incorporating online discussions into the classroom) over face-to-face learning. However, in the post-assessment, 50% of the students preferred blended learning (incorporating online discussions into the classroom) over face-to-face learning. This suggests that students see blended learning and online discussions as a viable method to meet student learning outcomes.

3. How might you further your skills/knowledge after this class is over?

The responses to this question changed quite a bit from pre- to post-assessment. In the pre-assessment, students' responses centered around resources provided by the instructor and within the institution. Sample pre-assessment responses are as follows:

- "I might review the lecture notes and read related books."
- "Ensuring that I read through the chapter and possibly do extra problems to get more practice."
- "Office hours with the teacher. Outside the realm of the teacher, I would go to a library to understand concepts."

However, in the post-assessment, students' responses centered around keeping up with real-world examples (e.g. current events, trends, news, research) to further skills and knowledge. This suggests that students are starting to recognize online discussions as a viable to further skills outside the classroom while still promoting student learning outcomes.

- "Continue to keep up with current events involving Environmental Chemistry and its systems."
- "Read more news articles on science as opposed to sports."
- "Continue to keep up with the latest research and development in wastewater and drinking water treatment."

<u>Scaled Comparison</u>

Table 5 provides results for the scaled comparison questions relating to student perceptions of the KEEN-focused discussion assignment. The average scores are all relatively high. The first two items (Applying learning in new contexts; Learning beyond the curriculum) focus on the student learning outcomes. The high scores suggest, from the students' perceptive, the KEEN-focused online discussions were especially effective as an aid to student learning outcomes. The latter four items (Formulating questions and generating own inquiries; Exploring alternatives; Encouraging diverse perspectives; Understanding diverse perspective) focus on the perceived

development of the entrepreneurial mindset. The high scores suggest, from the student's perspective, the KEEN-focused online discussions were especially effective as an aid to develop personality traits, behaviors, and skills previously linked to the development of the entrepreneurial mindset.

Table 5: Results - Student Perceptions of the KEEN-Focused Discussion Assignment

In comparison to other courses, how much has your coursework in this course emphasized the following? (5 = Very Much; 1 = Not at All)	Average Score
1. Applying learning in new contexts	4.5
2. Learning beyond the curriculum	4.6
3. Formulating questions and generating own inquiries	4.5
4. Exploring alternatives	4.4
5. Encouraging diverse perspectives	4.6
6. Understanding diverse perspectives	4.3

4 Conclusion and Recommendations

The purpose of this study was to respond to the following research question: How does the Kern Engineering Entrepreneurial Network (KEEN) framework build interest in technical topic areas, impact student learning outcomes, and develop the entrepreneurial mindset when applied to the engineering classroom?

In summary, there were positive correlations with the quality of the discussion prompts (as proxied by the average number of posts, average words per post, and average words per discussion session) and the quantity of KEEN 3C student outcomes. This result suggests that KEEN-focused online discussions have the potential to positively build interest in technical topic areas. Furthermore, the student self-report suggests a perceived greater impact on student learning outcomes. In addition, students perceived a greater coursework emphasis on Formulating questions and generating their own inquiries, exploring alternatives, encouraging diverse perspectives, and understanding diverse perspectives, all of which are considered aspects of the entrepreneurial mindset across multiple frameworks. Although not conclusive, this exploratory analysis provides insight into the potential implications of the KEEN framework and online discussions to positively impact engineering education. Future research should be deployed to further validate the repeatability and reliability of the study with a larger sample size and across different engineering courses.

References

1. Ireland, R.D., M.A. Hitt, and D.G. Sirmon, A Model of Strategic Entrepreneurship: The Construct and its Dimensions. Journal of Management, 2003. 29(6): p. 963-989.
2. Byers, T., et al., Entrepreneurship: Its role in engineering education. The Bridge, 2013. 43(2): p. 35-40.
3. Duval-Couetil, N., T. Reed-Rhoads, and S. Haghighi, The Engineering Entrepreneurship Survey: An Assessment Instrument to Examine Engineering Student Involvement in Entrepreneurship Education. Journal of Engineering Entrepreneurship, 2011. 2(2).

4. Dyer, J.H., H.B. Gregersen, and C.M. Christensen, The innovator's DNA. Harvard business review, 2009. 87(12): p. 60-67.
5. Clifton, J. and S. Bharadwaj-Badal, Entrepreneurial strengthsfinder. 2014.
6. Miller, D., The correlates of entrepreneurship in three types of firms. Management science, 1983. 29(7): p. 770-791.
7. Covin, J.G. and D.P. Slevin, Strategic management of small firms in hostile and benign environments. Strategic management journal, 1989. 10(1): p. 75-87.
8. Neck, H.M., P.G. Greene, and C.G. Brush, Teaching entrepreneurship: A practice-based approach. 2014: Edward Elgar Publishing.
9. Zhu, E., Interaction and cognitive engagement: An analysis of four asynchronous online discussions. Instructional Science, 2006. 34(6): p. 451-480.
10. Yang, Y.-T.C., A catalyst for teaching critical thinking in a large university class in Taiwan: asynchronous online discussions with the facilitation of teaching assistants. Educational Technology Research and Development, 2008. 56(3): p. 241-264.
11. Ellis, R.A., et al., Engineering students' conceptions of and approaches to learning through discussions in face-to-face and online contexts. Learning and Instruction, 2008. 18(3): p. 267-282.
12. Dunlap, J., Workload Reduction in Online Courses: Geting Some Shuteye. International Society for Performance Improvement, 2005. May/June 2005.
13. Shi, M., C.J. Bonk, and R.J. Magjuka, Time Management Strategies for Online Teaching. International Journal of Instructional Technology and Distance Learning, 2006.
14. Kelly, R., Group Work, Discussion Strategies to Manage Online Instructor Workload. www.facultyfocus.com, 2012.
15. Francis, J.W.P.M.E. and R.J. Booth, Linguistic Inquiry and Word Count. 1993, Technical Report, Dallas, TX: Southern Methodist University.
16. Vercellone-Smith, P., K. Jablokow, and C. Friedel, Characterizing communication networks in a web-based classroom: Cognitive styles and linguistic behavior of self-organizing groups in online discussions. Computers & Education, 2012. 59(2): p. 222-235.
17. Yoo, J. and J. Kim, Can Online Discussion Participation Predict Group Project Performance? Investigating the Roles of Linguistic Features and Participation Patterns. International Journal of Artificial Intelligence in Education, 2014. 24(1): p. 8-32.
18. Blikstein, P. Multimodal learning analytics. in Proceedings of the third international conference on learning analytics and knowledge. 2013. ACM.