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Work in Progress: An Exploration of Different Introductory Academic Opportunities in Innovation and Engineering Entrepreneurship

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Abstract
This work-in-progress paper explores three different academic opportunities that introduce undergraduate students to innovation and engineering entrepreneurship. Courses focused on the explicit teaching of knowledge, skills, and attitudes associated with innovation and entrepreneurship are inherently able to include learning objectives that align with many of the ABET student outcomes, including how to: understand the context in which an engineering design will be implemented, effectively communicate ideas, work in multidisciplinary teams, and participate in ethical decision making. The three academic opportunities offered at the University of Illinois Urbana-Champaign which are discussed in this paper include: 1) a semester-long introductory course in innovation, leadership, and engineering entrepreneurship that is open to students of all majors and levels; 2) a year-long innovation course designed for first-year students who must apply and be accepted into this academic program; and 3) a semester-long introduction to innovation course that is available exclusively to students living in a certain residential living-learning program for first- and second-year students. The first two courses have typical enrollments of 40 students or less while the third course enrolls between 100-150 students when it is offered each fall. This exploration will discuss the importance of formally introducing students to innovation and entrepreneurship early in their academic careers, specific curriculum and student assessment mechanisms in each of these programs, and in what ways participating students stay engaged in the innovation and entrepreneurial ecosystem after completing one of these three introductory courses.

1. Introduction

The Technology Entrepreneur Center at the University of Illinois Urbana-Champaign (UIUC) exists to help students develop an entrepreneurial mindset and change the way they see the world to tackle important challenges [1]. This is achieved through both curricular and co-curricular opportunities available to undergraduate and graduate students in primary degree programs from across campus. The Center provides a variety of resources for students, including courses and academic programs, workshops, networking opportunities with mentors and faculty, travel experiences, access to funding, and new venture competitions, among others.

This paper explores three distinct, introductory curricular opportunities that students can engage in to gain foundational knowledge and project-based experience in engineering entrepreneurship and innovation. Students participating in these classes are enrolled both in primary engineering programs as well as in disciplines across various colleges at UIUC and each course was developed for a specific context to provide ample opportunity to many students for early engagement in the entrepreneurial ecosystem.

2. Motivation

The development and sustained offering of multiple introductory courses in innovation and engineering entrepreneurship is driven by a variety of motivations. First, the Grainger College of Engineering is committed to formally developing the entrepreneurial mindset of its students. As

defined and described by KEEN [2], the entrepreneurial mindset is facilitated through the KEEN 3C's of Curiosity, Connections, and Creating Value and is marked by the ability for individuals to:

- Have a constant curiosity about our changing world and employ a contrarian view of accepted solutions.
- Habitually connect information from many sources to gain insight and manage risk.
- Create value for others from unexpected opportunities as well as persist through, and learn from, failure.

This entrepreneurial mindset is aligned with ABET student outcomes [3-5]. These outcomes include how to understand the context in which an engineering design will be implemented, effectively communicate ideas, work in multidisciplinary teams, and participate in ethical decision making. While courses across all disciplines and levels can embed pedagogical elements to enhance students' entrepreneurial mindsets, courses focused explicitly on engineering entrepreneurship and innovation have a unique opportunity to provide a rich learning environment focused on developing this mindset. This can be facilitated in a multitude of ways, including through experiential opportunities, the utilization of active learning techniques, and interest-based team projects (i.e., open-ended topic selection).

Courses targeted to first- and second-year undergraduate audiences can be structured as low credit hour, introductory courses (e.g., 100-level and one credit hour) with the goal of minimizing risk and providing low impact on a student's course schedule. Furthermore, introduction courses that are purposefully and pedagogically designed and facilitated have the potential to help promote an overall sense of inclusion and belonging for all students in the entrepreneurial ecosystem. These entrepreneurial ecosystems, available in varying degrees across many university campuses, provide unique and exciting resources and opportunities to students. Early exposure to these ecosystems can increase the likelihood of sustained student engagement and growth in creativity, design, innovation, and technology commercialization.

3. Overarching Learning Objectives for Introductory Courses

The three introductory courses in innovation and engineering entrepreneurship offered at UIUC through the Technology Entrepreneur Center were developed to provide students with a variety of academic pathways in which they could both better understand the campus' entrepreneurial ecosystem and available resources (e.g., funding, mentorship) as well as provide a setting in which students can build their creative confidence and sense of belonging within the ecosystem. Subsequently, the three courses described in this paper share certain formal learning objectives. However, each course provides different formative and summative assessments as well as varying in-class content and activities. The shared objectives can be summarized and described as follows:

By the completion of these courses, students will be able to:

1. Define innovation and entrepreneurship,
2. Understand the entrepreneurial mindset and assess and develop their entrepreneurial identity,
3. Identify problems and opportunities for improvement,
4. Generate novel and innovative ideas,

5. Collaborate and lead others in innovation,
6. Communicate and pitch ideas effectively to a broad audience, and
7. Summarize the availability of innovation and entrepreneurship campus resources at the University of Illinois Urbana-Champaign and understand how to utilize them.

These objectives are designed to expand students' knowledge, skills, and attitudes in a way that would benefit them as engineering innovators regardless of whether they seek roles in entrepreneurship, intrapreneurship, research, or academia.

4. Introductory Courses

The three introductory courses were developed for different programmatic experiences. The first, TE 100: Introduction to Innovation, Leadership, and Engineering Entrepreneurship, is a semester-long general introductory course in innovation, leadership, and engineering entrepreneurship that is open to students of all majors and levels. The second, ENG 177: GFX Innovation Scholars, is a year-long innovation course designed for first-year students who must apply and be accepted into the Grainger First-Year Experience (GFX) Scholars program. The third, TE 200: Introduction to Innovation, is a semester-long introduction to innovation course that is available exclusively to students living in a certain residential living-learning program for first- and second-year students. Each course meets for one 50-minute session per week throughout a 16-week semester. The first and third courses meet for only one semester while the second course for the Scholars program is two semesters in length. While all courses are currently only offered in-person, TE 100 and TE 200 successfully transferred to synchronous online formats during 2020 and 2021. Table 1 provides additional characteristics of these courses.

Course Characteristic	**Introductory Curricular Experience**		
	TE 100	**ENG 177**	**TE 200**
Length of course	One semester	Two semesters	One semester
Credit hour	One	One per semester	One
Frequency of offering	Fall and Spring semesters	Begins Fall semester and continues in Spring semester	Fall semester
Admittance structure	Open to students from all disciplines across campus	Application process for admittance to Grainger First-Year Experience Scholars program	Application process for admittance to the Innovation Living Learning Community
Student level	Undergraduate students of all levels	Exclusively first-year students	Predominantly first-year students: 89% first-year in Fall 2021; 92% in Fall 2022

Table 1. Characterization of three introductory curricular experiences.

The three courses are all structured to support an active learning classroom environment, with frequent discussions and activities, limited yet intentional lecture time, one to two project presentation and structured peer feedback sessions, and occasional guest speakers. To lower the barrier to entry, each course was designed as a one credit hour course (equivalent to three hours of work each week for 16 weeks, including time spent in class and assignments completed outside of class). In order to support frequent instructor-student interaction and individualized feedback, enrollment for each individual course section is capped between 25-50 students. TE 200 is only offered in the fall semesters and, given the number of students who live in the Innovation Living Learning Community at UIUC, has multiple sections taught by an instructional team. In general, instructors are faculty and staff affiliated with the Technology Entrepreneur Center. Table 2 provides enrollment data for four semesters.

Introductory Course Experience	**Enrollment by Semester**			
	Fall 2021	**Spring 2022**	**Fall 2022**	**Spring 2023**
TE 100	18, 9 (online)	29, 8	25	35
ENG 177	Not offered	Not offered	19	10*
TE 200	25, 29, 26, 34, 34 (148 total across 5 sections)	Not offered	25, 25, 19, 24, 27, 26 (146 total across 6 sections)	Not offered

**Attrition rate was anticipated due to scheduling conflicts with students' primary degree course requirements*

Table 2. Enrollment data for three introductory curricular experiences.

All courses utilize the same learning management system and have distinct grading rubrics for the assessments. Each of the three courses is described in further detail in the following sections, which include an overview, specific course topics, and summaries of the primary assessment mechanisms.

4.1 TE 100: Introduction to Innovation, Leadership, and Engineering Entrepreneurship

This course serves as the general introductory course in engineering entrepreneurship and is open to students of all undergraduate levels from disciplines across campus. It is also the first course in the curriculum for the BS in Innovation, Leadership, and Engineering Entrepreneurship dual degree offered through the Grainger College of Engineering. Overarching course topics include:

- Defining innovation, leadership, and engineering entrepreneurship
- Historical innovators and innovations
- Sustaining and disruptive innovations
- Foundations of entrepreneurship
- Identifying problems and opportunities
- Discussing attributes of innovation leaders
- Brief description of the ten types of innovation [6]
- Introduction to the entrepreneurial ecosystem and resources at UIUC
- Exploring academic opportunities in innovation and entrepreneurship
- Curricular and co-curricular opportunities after the conclusion of the course

Students submit a variety of assessments of varying point valuations throughout the semester, typically one per week. The first of three primary assessments is a team project, segmented into

a project proposal, final team pitch, and final team report. Prior to beginning work on this project, students are given opportunities to work with a variety of peers during class activities and then given structured time during class to form a team of two or three total members. This project provides students a framework for exploring problem spaces of which they share mutual curiosity, developing multiple ideas to address this problem, discuss their ideas with experts, develop and deliver an inspiring pitch, and write a brief implementation plan and complete a business model outline.

The second assessment is an active learning, peer teaching activity [7]. Students prepare a 15-minute lesson to teach a small peer group about the content of an episode of the NPR *How I Built This* podcast through a brief lecture, engaging activity, and a discussion or quiz as a means of assessment. This activity exposes students to the paths that various innovators took in their entrepreneurial journeys to demystify the process of innovation and provide inspiration through storytelling.

The third primary assessment mechanism is an individual innovation map and synthesis. The objective of this assignment is to provide a formal means for students to reflect on potential next steps in their entrepreneurial journey after the course ends and synthesize their understanding of the entrepreneurial mindset and their role as an innovation leader. Students complete this by creating a digital, visual collage and writing a prompt-based reflection.

4.2 ENG 177: GFX Innovation Scholars

This course was developed to be part of the Grainger First-Year Experience (GFX) Scholars program. Prior to entering their first year in the Grainger College of Engineering, students can apply to participate in one of eight distinct experiences throughout their first year as a GFX Scholar. The other section topics offered during the 2022-2023 academic year include leadership, projects, research, global sustainability, global disaster resilience, career, and the technology and innovation ecosystem in Chicago, Illinois. Scholars' sections have small enrollment maximums (e.g., ENG 177 has a capacity of 20) in part to foster a sense of sustained community and belonging among students. The course topics include:

- Defining innovation
- Historical innovators and innovations
- Students' role as innovators
- Introduction to the entrepreneurial ecosystem and resources at UIUC
- Understanding the role of assumptions and hypotheses in innovation
- Defining impact in innovation
- Exploring academic opportunities in innovation and entrepreneurship
- Empathy and understanding stakeholder needs
- Finding inspiration
- Techniques in ideation
- Sustaining innovation
- Testing hypotheses
- Providing constructive peer feedback
- Curricular and co-curricular opportunities after the conclusion of the course

Students submit weekly assignments in this course, including many pre-class activities that are designed to expose students to course topics before they are discussed in class. These activities include personal reflections and written responses to questions after watching videos, listening to podcasts, exploring websites, and reading articles. The most valuable assessments in the first semester of the ENG 177 course include an innovation portfolio and two innovation breakthroughs.

The innovation breakthrough projects are completed individually, and students produce a slide deck that they formally present during class. The first asks students to choose a problem area that is compelling to them, research the problem area, develop a multitude of ideas to address a root of this problem, and choose one to visualize and justify. The second has students select an existing technology that is interesting to them, develop a variety of ways to innovate and improve this offering, select one to visualize and justify, and then create a video to showcase their final innovation. The innovation portfolio is a summative assessment and asks students to systematically compile the knowledge that they have gained throughout the semester and reflect on their future role as innovators in entrepreneurial or intrapreneurial endeavors.

The second semester of this course also includes pre-class activities and further development of their innovation breakthroughs in which students must choose a single project to pursue and develop a Business Model Canvas, minimum viable product, and compelling pitch of their idea to share with the class. Also incorporated into the class are field trips to visit spaces offering design, innovation, and entrepreneurship resources as well as brief shadowing opportunities of individuals working in varying innovation roles (e.g., research labs, start-ups, and research and development within established companies and organizations) and in-class guest speakers (e.g., faculty innovators, students working on start-ups, individuals involved in research).

4.3 TE 200: Introduction to Innovation

Students at UIUC can elect to live in the Innovation Living Learning Community (ILLC) through University Housing. The ILLC is one of eleven current community offerings and was created to support student's creative and entrepreneurial interests and provide courses, workshops, access to financial resources, and a dedicated makerspace. Students who live in the ILLC can take TE 200 as a one credit hour introductory course during the Fall semester. They then have a few additional curricular options offered exclusively for this community during the Spring semester, including a seminar-based course and a project-based course. The topics covered in TE 200 include:

- Students' entrepreneurial identity and reflection on innovation
- Enhancing curiosity
- In-depth exploration of the ten types of innovation [6]
- Exploring innovation beyond product and service design
- Introduction to the entrepreneurial ecosystem and resources at UIUC
- Exploring academic opportunities in innovation, entrepreneurship, and technology management
- Delivering an effective pitch
- Generating value with innovation
- Curricular and co-curricular opportunities after the conclusion of the course

Similar to the other introductory courses, students complete weekly assignments of varying degrees of difficulty in order to maintain pedagogical momentum between once-a-week class sessions. Students complete an initial reflection paper on their identity as it relates to their entrepreneurial mindset and attend and reflect on two events with an entrepreneurship or focus throughout the semester. The major assessment is a project that culminates in a public event like a poster session or demo day, with the most recent rendition entitled the Idea Fair and Celebration. Students can elect to work individually or with a team of no more than three other students on this project. Teams then explore a project concept, identify various methods to innovative on their idea and business model or implementation plan, and then create a visual of their concept and a corresponding poster to display at the event. In addition to celebrating student effort and dedication, projects are also judged for novelty and usefulness and are eligible for monetary awards to be used for continued project work and prototyping.

5. Opportunities Beyond Introductory Courses

A primary objective of the introductory courses is to expose students to the resources and opportunities available to them. These are intentionally discussed during various class sessions and students are also shown a slide during class with a summary of upcoming events, workshops, and award opportunities. Further, in TE 100 and TE 200, students are asked to attend an innovation-focused event on campus and submit a brief reflection as part of their grade. This section provides a general overview of the curricular and co-curricular opportunities available to students at UIUC, although there are also various registered student organizations associated with entrepreneurship available to students on campus.

5.1 Curricular Opportunities

Students can participate in a variety of curricular programs in entrepreneurship, innovation, creativity, and design thinking at UIUC. These courses are both of varying credit hours and levels, with offerings for both undergraduate and graduate students. The three different introductory courses described in this paper dedicate class time to helping students understand other courses that they might be interested in taking throughout their academic careers. Students can take these courses as free electives, or they can elect to take a grouping of courses and earn a certificate offered through the Technology Entrepreneur Center or the BS in Innovation, Leadership, and Engineering Entrepreneurship dual degree program, which is available to students with a primary degree in engineering.

5.2 Co-curricular Opportunities

Various co-curricular opportunities exist at UIUC to engage students in innovation and entrepreneurial endeavors, and many students participate in both these and curricular experiences. Co-curricular opportunities range from non-credit bearing short workshops and guest speaker events, group travel experiences, and a new venture challenge. The Technology Entrepreneur Center coordinates and facilitates many of these opportunities [8], and some of the most popular offerings are described here:

- Entrepreneurship Advising: These weekly office hours are hosted by Center staff and student ambassadors with the goal of answering student questions related to pursuing start-up ideas at UIUC.
- SocialFuse: Held multiple times throughout the academic year, this pitching and networking event seeks to connect students who are working, or looking to work, on a

new venture. SocialFuse events are open campus-wide and are typically held for a few hours in the evening at various locations.

- Silicon Valley Entrepreneurship Workshop: This application-based, week-long event occurs each winter and is open to students of all levels and programs. Students visit and learn from UIUC alumni who are now part of the entrepreneurial community in the Silicon Valley area.
- Cozad New Venture Challenge: Cozad is the UIUC campus' largest new venture competition and is open to all students. The program runs for about two months each spring semester and all teams are invited to participate for the duration of the challenge. The primary goals of Cozad are to educate students along their entrepreneurial journey through mentoring and mandatory and optional workshops (e.g., customer discovery, value propositions, financial projections, effective pitching) and to accelerate ventures of all stages through various levels of funding, in-kind prizes, and awards. Students are invited to participate in multiple iterations of Cozad.

6. Conclusion and Future Work

Engineering entrepreneurship and innovation education provides a great opportunity to facilitate the development of the entrepreneurial mindset in students. The three courses described in this paper were intentionally developed to provide students in different programs who are interested in innovation with an accessible, formal way of enhancing their entrepreneurial confidence and knowledge of resources. Engineering programs would benefit from providing introductory curricular experiences in order to increase participation and sustain engagement in their entrepreneurial ecosystems and programs. This is accomplished through these courses by providing students: 1) dedicated and in-depth exposure to campus resources, 2) regular interactions with instructors who can support and encourage students, and 3) open-ended, experiential project opportunities that allow students to practice their innovation, creativity, and engineering entrepreneurship skills while working on project topics that are of particular interest to them.

Finally, it is anticipated that the Idea Fair and Celebration for the Innovation Living Learning Community is expanded upon in future iterations to include project teams from a variety of introductory courses in innovation, design, and entrepreneurship from across campus. The primary goals of this event are to bolster student confidence in their creative abilities, publicly celebrate curricular student effort, and encourage students to continue engaging in the campus entrepreneurial ecosystem if they are inclined. Future work will further discuss the objectives and logistics of this event as well as the resulting implications on student entrepreneurial mindset growth and recommendations for implementation at other institutions.

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References

[1] "What is TEC?," *Technology Entrepreneur Center | UIUC.* [Online]. Available at https://tec.illinois.edu/about.

[2] "The Entrepreneurial Mindset," *KEEN - Engineering Unleashed.* [Online]. Available at https://engineeringunleashed.com/mindset.

[3] "Criteria for Accrediting Engineering Programs, 2022 – 2023," *ABET*. [Online]. Available: https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2022-2023/.

[4] Petersen, O. G., & Jordan, W. M., & Radharamanan, R. (2012, June), *Proposed KEEN Initiative Framework for Entrepreneurial Mindedness in Engineering Education* Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas.

[5] Estell, J. K. (2020, June), *"EMbedding" the KEEN Framework: An Assessment Plan for Measuring ABET Student Outcomes and Entrepreneurial Mindset* Paper presented at 2020 ASEE Virtual Annual Conference.

[6] Keeley, L., Pikkel, R., Quinn, B., & Walters, H. (2013). *Ten types of innovation: The discipline of building breakthroughs*. Wiley.

[7] Jahnke, K., & Lindgren, S. (2021, July), *You Teach Us: Peer Teaching in the Engineering Classroom* Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference.

[8] "Programs," *Technology Entrepreneur Center | UIUC.* [Online]. Available at https://tec.illinois.edu/programs.