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Single-class Infusions to Integrate the Entrepreneurial Mindset into First-year Experiences

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Single-Class Opportunities to Integrate the Entrepreneurial Mindset into First-Year Experiences

Abstract

One recent paradigm-shift in general engineering education has been the inclusion of the Kern Entrepreneurial Education Network's philosophy of the Entrepreneurial Mindset (EM) as a means of developing student curiosity, helping students to make connections, and ultimately finding ways to create value through engineering. Multiple attempts at infusing EM have been explored and developed throughout recent years, including into first year engineering programs, capstone courses, elective courses, and other core technical courses. However, much of the shared faculty-examples of the new EM-infused content involves adding or revising an existing term project, or revision of an entire course completely. These large time-investments in EM can be effective, but faculty may be hesitant to alter their courses so substantially. By identifying single-class opportunities to integrate pedagogically-sound practices that meet both EM and ABET outcomes, faculty can excite their students, meet class and program learning objectives, and enjoy teaching.

This paper explores the effectiveness of single-class infusions in developing the learning outcomes and skillsets related to an entrepreneurial mindset. An initial analysis of existing available resources related to instilling the entrepreneurial mindset provided on the Engineering Unleashed website is included and suggests that single-session resources may be hard to find, and that they often lack details important for implementation such as the time required to facilitate the activity. Four distinct examples of single-class infusions of EM implemented during the Fall 2018 semester in a first-year engineering course at Arizona State University are provided as examples. Qualitative results from student survey data explore the impact that single-class EM opportunities can have on first year engineering students.

1. Introduction

1.1 Entrepreneurship in engineering education

Engineering programs are continuously redesigning themselves to stay current with popular demand from their paying students as well as from funding organizations. Even as far back as 2010, there was a critical mass of ASEE member schools incorporating entrepreneurship into engineering education, with over half offering entrepreneurship initiatives, and 25% offering formalized programs that resulted in credentials [1]. Students often have the choice to explore entrepreneurship in a variety of methods, including courses through the business school, innovation courses co-listed and co-taught between academic colleges such as business and engineering, startup competitions, entrepreneurship clubs, and even entrepreneurship REUs. However, for students to reap the benefit of these offerings, students would have to actively choose to participate in the initiatives.

Engineering student preferences for learning entrepreneurship through isolated academic endeavors from their existing coursework varies. In one study, students who were required to take a separate entrepreneurship course as a part of their engineering degree viewed their entrepreneurial-learning in one of four ways: as a "first step to self-directed learning, preparation for work life, path to possible self-employment, or the context for developing leadership and responsibility for team achievement" [2]. After completing the required course, some students agreed that the entrepreneurship content was useful, but others argued it should be voluntary. However, most students found the skills learned from entrepreneurship to be useful for personal development and general career preparation. As another example, an entrepreneurship club failed, with the faculty member hypothesizing that there was not enough momentum from the students since those who took entrepreneurship courses were not interested in continuing with the club [3].

1.2 Entrepreneurial Mindset

As an alternative to teaching formal entrepreneurship in a silo, engineering faculty have begun to introduce the topics and skills related to entrepreneurship in more discipline-specific courses. The Kern Entrepreneurial Engineering Network (KEEN) is a network that encourages the adoption and implementation of an entrepreneurial mindset (EM) [4]. In summary, the entrepreneurial mindset encourages students to be "curious about the changing world, make connections from disparate information, and create extraordinary value for themselves and their communities" [4]. Multiple examples of integrating EM into engineering programs have been explored and studied, including examples in first-year engineering courses [5-8], capstone courses [9,10], extracurricular experiences [3,11], camps or multi-week non-academic programming [11,12], supplemental instruction [13,14], and even within discipline-specific core courses or technical electives [15,16].

How well do these in-class experiences fit into the context of promoting an entrepreneurial mindset, while still largely tasked with covering more-traditional technical content? In a study of four schools that adopted an entrepreneurial mindset approach to their engineering capstone projects, it was found that students may not directly associate their course with being an entrepreneurial experience, potentially due to students' lack of understanding between entrepreneurship and entrepreneurial [10]. When incorporated into required classes, some students surveyed by Davis et al. felt the entrepreneurship activities in their class were a waste of time and seemed forced, with entrepreneurship lessons being something that would have been better learned in an industry environment such as a co-op or internship [16]. Jensen found students were more likely to use customer interviews to confirm their ideas rather than learn about customer wants and musts before brainstorming [8]. Regardless of these challenges, the majority of studies represent examples of some degree of success: in a supplemental capstone course to apply entrepreneurial mindset to existing projects, the majority of students met learning objectives according to a self-assessment via Likert-scale questions based on various entrepreneurial-mindset competencies [14].

1.3 Engineering Unleashed- a resource for faculty

While the effectiveness of these efforts is still under discussion since it is not clear exactly how we should assess the student learning of an entrepreneurial mindset in such varied formats, there has been widespread adoption of entrepreneurially-minded learning. In order to share course materials, many faculty participate in the online community at EngineeringUnleashed.com [4].

As a part of the platform, faculty can sign up to share and access materials focused on entrepreneurial mindset via unique webpages called “Cards”. Most card are documented examples of an approach to incorporating the entrepreneurial mindset into an academic activity, class, or program. Users of the site can search the cards to learn from others’ ideas; as of January 31, 2020, there were over 1000 cards published for faculty to peruse.

With an intent of sharing knowledge and best practices, one goal of the published cards should be transferability- could another faculty member use the documented ideas and resources at their own institution? Unfortunately, not every card is a useful resource for adaptation. Some cards lack details or additional uploads of lesson plans, leaving readers looking for more information. Other cards lack clear indications of what the activity entails, or how much time it will take. Additionally cards can be thoroughly well documented, but may be less adaptable because they contain too much information. As an example, many cards provide details on an entire course that has been modified to meet some of the entrepreneurial mindset competencies. However, unless a university plans to design a new course or offer a new technical elective, the provided high-level overview of a course is likely not helpful. As an example, one faculty member commented on a card, “*This project is well thought out and comprehensive. If I were designing a course from scratch I would strongly consider using this as the thread through the course as the authors did*,” [17], and plenty of other supportive but not-ready-as-is comments exist on the card pages. Ultimately, engineering faculty already feel the pressure of having to teach too many topics within each course, and many faculty members have trouble finding the time to incorporate entrepreneurially-minded learning into their courses [16]. Shared resources that are full courses or even month-long projects are unlikely to be adapted by other faculty into their existing courses as it would require removing other material unless the learning outcomes and disciplinary technical knowledge of the card had complete overlap, an unlikely occurrence.

Other cards that are not intended to be used directly in the classroom are those cards intended to provide materials to accompany a workshop, institution-level approaches to institutionalizing the entrepreneurial mindset, or even shared pedagogy tools such as assessment rubrics. While many of these are useful and are possibly applicable to a classroom activity, the provided resources are less likely to be a direct resource that can be inserted into a week of class materials. It is suggested that the smaller the scope of the materials provided and documented in a KEEN card, the more likely faculty are to be able to adopt those resources into their own courses.

In order to meet this need, the author has explored existing examples of single-class infusions of EM activities. With university structures and class schedules often varying across campuses and institutions, a single-class opportunity is defined as an activity or lesson implementing an EM outcome or skill that takes no more than 90 minutes of classroom time to complete. Additional work could be assigned as pre-class exercises or homework as long as there is no further in-class time devoted to the specific topic or activity, and the entire timeline of the content, including homework, should take no more than week.

1.4 Existing assessment of an Entrepreneurial Mindset

A quick google search of “Can Entrepreneurship be Taught?” reveals hundreds of articles arguing both yes and no, debating between skills (business), luck, insight, passion, and more.

The KEEN EM structure takes the ideas affiliated with entrepreneurial thinking and breaks them into smaller mindset objectives (Curiosity, Connections, Creating Value). These are still somewhat vague, which has inspired Ohio Northern University's creation of the expanded KEEN student outcomes (eKSOs) [18]. The reliability of these eKSOs with respect to assessment is still being explored, and future work will be needed to explore if student skills in the eKSOs framework could be developed in the timespan of a single class period.

1.5 Research questions

Motivated by the literature, this research study examines:

1) To what extent are faculty sharing their examples of single-class infusions of entrepreneurially-minded learning as cards on the Engineering Unleashed website?
2) Are there defining characteristics (i.e. discipline, targeted course) of single-class cards?
3) To what extent can students develop their entrepreneurial mindset from a single-class, EM opportunity?

2. Methodology

To understand the full scope of Engineering Unleashed cards currently available for faculty as peer resources, a systematic analysis of the card published to Engineering Unleashed was completed. Cards were classified according to their type of content, audience, and expected completion time. Cards that fit the definition of single-class infusions were examined in depth for defining characteristics. The author defines a single class period of materials at 90 minutes or less of classroom time. However, this definition is only a starting point as some classes meet for 50 minutes for a class period and other meet once a week for 3 hours at a time. As such, there is no single definition of a "single-class infusion" and ultimately it is will be up to each faculty member to determine if a card will fit within their specific classroom structure, timeline, and learning objectives. As complementing material, the author showcases how various topics can be introduced in as little as a 50 minute class period with four examples designed for an introduction to engineering class, providing examples of content as well as the accompanying student assessment.

2.1 A systematic review of cards

A systematic review of published Engineering Unleashed cards was performed to determine to what extent existing resources promoting EM focused on single-class activities. With over 1000 published cards available for view as of January 31, 2020, sampling was performed for the review process. Cards were sorted based on their date of last modification as saved in the Engineering Unleashed website. Cards are uploaded and edited throughout the year, but there is often a large influx of cards around the annual KEEN conference early in January. To balance this while still using a systematic process, the author used all 20 cards from 2017, 195 cards from those published in 2018 starting on Jan 1, 2018, and 205 cards analyzed from 2019 accessed in reverse calendar order starting Dec. 31, 2019. The initial review stage categorized each of the 400 cards based on the type of information it included and the intended participants of the card's resources or programming. Overall content categories for cards included:

- Classroom-focused: classroom resource, lesson plan, or course overviews
- Outreach-focused: events or activities for K-12 students or general public
- Extra-curricular programs: student organizations or non-event, non-academic programs
- Event-documentation: materials/documentation from workshops, conferences, or events
- University-level: resources for university-level approaches to entrepreneurial mindset
- Information/training: book reviews, how-to guides, card decks, KEEN updates
- Unknown: materials for which the intended purpose is unknown or cannot be inferred

Cards that focused on classroom practices or activities were then further classified by the type of classroom activity, length of in-class activities, and length of out-of-class activities. Cards were not classified in the various categories if they did not include appropriate information in either the card summaries or in additional uploaded material descriptions. In some circumstances, a card could be classified for two different categories under the same section if relevant (e.g., discussing a general teaching methodology and also providing a class-specific example). On the other hand, if a card had multiple classroom activities but they were all included in the same card, it was only counted once.

Once the 400 cards were sampled, a smaller sub-sample of 30 cards specifying 90-minutes of content or less were reviewed for further details. Characteristics that were analyzed included: EM mindset objectives, EM skillset objectives, main discipline, audience academic level, type of activity, and any accompanying pre-work or homework for students to complete. The result of the card analysis begin in Section 3.1.

2.2 Created examples of single-class EM infusions as cards

The author has created a set of four single-class infusion cards to be implemented originally in a first-year engineering curriculum at Arizona State University. The class was a multidisciplinary experience with a maximum of 40 students enrolled in a section. The goal of these cards was to cover a wide variety of entrepreneurial mindset outcomes without relying on a single project. The four topics selected were engineering economics, customer awareness and stakeholders, engineering ethics, and value propositions and supporting data. Two of the four lessons were taught as a supplement to the existing class project, but could be used either with any class project or as stand-alone modules in classes without a project. A summary of each card is provided below. These cards were implemented into the curriculum in the Fall 2018 semester with a class size of approximately 20 students in an honors section, though the materials were not designed exclusively for use with honors students.

2.2.1 Example 1: Engineering Economics- Amazon Headquarters

The first topic introducing entrepreneurial mindset was intended to make engineering economics a more exciting topic for students to understand. The existing resources attempted to relate to students by discussing how much money was spent on a degree and the price of student loans to pay it off, as well as introducing topics such as startup versus operating costs and how to calculate the 10-year return on investment. In the new version, students were introduced to the topic by asking them to determine where Amazon should place their next headquarters. As a topic of recent events and a company all students were familiar with, students had to decide what variables a company should consider when determining a headquarters location. Locations were limited to three pre-determined cities and one city of the students' choosing. Students work in their teams of up to four students to implement the same mathematical formulas of the class lecture, but the specific numbers came from their own research rather than being assigned in a class problem description. Some students decided real-estate cost was an important consideration and looked up the average price per square foot to build an office building in the various cities. Others looked up news articles to determine tax breaks, and others looked at average salaries to estimate the annual payroll. Students had one 50-minute class period during which introduced the content, there were class discussions, and students made a plan for what type of information they wanted to research to make their argument. Teams ended class by submitting a copy of their plan to the faculty for approval before completing the research and one-page proposal due one week later. Individual students had to prepare a half-page statement regarding a specific risk the company was taking in selecting their location, and how it could be minimized, which increased individual accountability to the team assignment. Resources for this class are available online [19].

2.2.2 Example 2: Introductory Market Research, Stakeholders, and User Scenarios for Project-Based Classes

The second topic introduced into the first-year engineering program was a single 50-minute class period active-learning lesson which introduces various topics related to market research. The class started off by asking students to identify the single-most important product that they had purchased or received as a gift. This reflection led them to identify that most engineering disciplines contribute to product development at some level. In order to have a successful product design, engineers should consider both the users and the competing market during the design phase. Students and faculty then discuss tools such as competitive market research, stakeholder identification, and user scenarios through examples, with constant breaks for students to stop and apply the topics to their own project (underway in the class already). Students worked during class with their teams to complete the worksheet documenting the introductory market research for their existing project. If students did not finish, the handout was assigned as homework due in one week. Resources for this class are available online [20].

2.2.3 Example 3: Identifying Project to Product Opportunities- Assessing Value and Testing Protocols

The third 50-minute class activity introduced students to the idea of taking a project and turning it into a product. Students were asked to "sell" a specific pencil to their peers, with many of them realizing that to sell a pencil, someone needs to be convinced they need a pencil and that the pencil has value. Students learned to create a value proposition statement, and were then inspired by "As-Seen-On-TV" ads to support their arguments with data and validation through both quantitative and qualitative testing. By the end of the class period, students were asked to create and complete a testing plan for their existing class project prototype, determining quantitative measures they planned to conduct as well as qualitative questions to ask potential customers when testing their prototype. The team handout was intended to be completed in class, but could be assigned as homework with minimal time commitment from students expected. Resources for this class are available online [21].

2.2.4 Example 4: Bulletproof Vests: Ethics Case Study and Risk Management

The final 50-minute class activity was designed to test student assumptions about ethics through a case study of Second Chance Body Armor, which ignored engineers' reports and concerns that the bulletproof vests were not living up to expectations. The faculty starts class by asking how much money it would take for the students to be willing to cheat on a test- most agreed that $1000 would be a fair price, but only because it didn't hurt anyone and was only dishonest. Students were then prompted to determine what price point would matter if it did hurt someone, specifically by following along with a case-study. The slide deck documented the discovery of materials, emails from company execs, testing results, and snippets of legal court summaries building the timeline of a company's downfall. Along the way, students were asked: *if you were in this role, what would you do next?* By the end, students were able to see "both sides" of the ethics story and learned about whistleblowers. No assignment was created for this lesson as it was used on the last day of class, but possible assignment suggestions are provided online [22].

Instructor comments on facilitating all four cards and results of the student self-assessments for meeting learning objectives were summarized after implementation in Section 3.4.

3. Results and Discussion

3.1 Engineering Unleashed card analysis

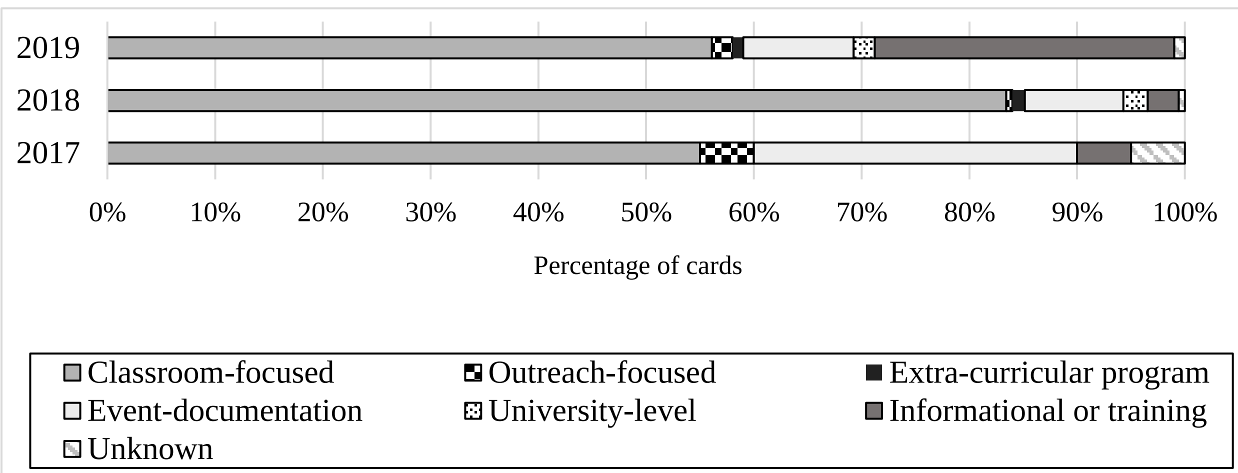

Figure 1: Distribution of sampled cards based on information content category

Figure 1 shows the distribution of sampled cards from each year based on the various types of content they include. From the 400 cards analyzed on EngineeringUnleashed.com, the majority each year were classroom-focused. While it appears most faculty used cards to document and share their classroom initiatives, starting in 2018 more informational and/or event cards were published. Each workshop presented at the annual KEEN conference has an accompanying card, and other events hosted by KEEN or KEEN university partners may also have accompanying cards for sharing resources from the event. The number of informational or training cards from the sampled 400 cards grew from 1 card in 2017 to 5 cards in 2018 to 57 cards in 2019. This growth was likely attributed to new KEEN initiatives that were documented in the sampled cards including university book clubs, card decks (a 'directory' card that links multiple cards based on technical topic), and an increase in the publication of assessment tools for EM learning objectives. While Engineering Unleashed does not have a restriction on the type of content included on a published card, it is possible that a smaller percentage of classroom-related card could make it harder for a faculty member to find and adopt a classroom activity resource.

Due to the nature of the Engineering Unleashed platform, the audience of all cards are faculty and staff members who plan to implement EM activities. However, some cards are intended to be used in a classroom where students are the beneficiary of the activity and learning outcomes, while others are purely information or resources or faculty to enhance their own mindsets. This differentiation motivated an analysis of who was the intended participant from each card. Figure 2 shows the percentage of intended participants separated by year. Many of the informational and event cards were intended for a faculty audience, mirroring the 2018-2019 pattern from Figure 1.

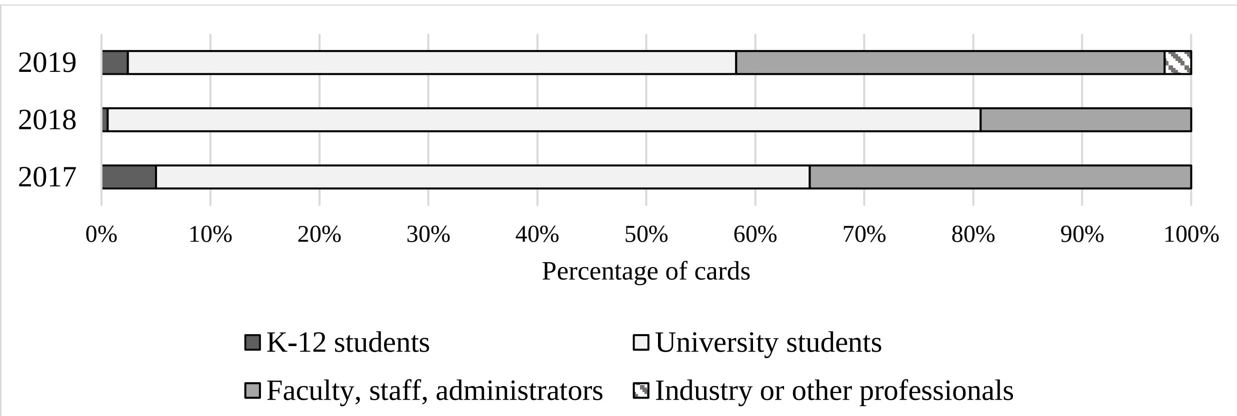

Figure 2: Intended participants from sampled Engineering Unleashed cards

Classroom-focused cards were those cards that shared a classroom resource, pedagogy, or course outline that usually had university students as the intended participants. There were 11 cards from 2017, 146 from 2018, and 115 from 2019 for a total of 272 cards or 68% of the sampled cards. However, the course cards varied greatly with respect to the type of content they shared, with Figures 3 and 4 showing some of these patterns. Figure 3 shows the number of different types of classroom-related cards over the years. It can be seen that the most-provided resource are project descriptions or summaries, followed by activity or lesson plans, and then full course overviews. One possible reason for the large difference between the number of course overviews in the years 2018 and 2019 is due to the limited number of new full courses that are being created with EM- once a course has been shared as a card, it is documented and does not require additional cards. The platform started in 2017 and thus most universities took the opportunity to document full-courses early on. However, courses can constantly add new activities and faculty may choose to share those individual resources as they are developed, contributing to cards with later publication dates.

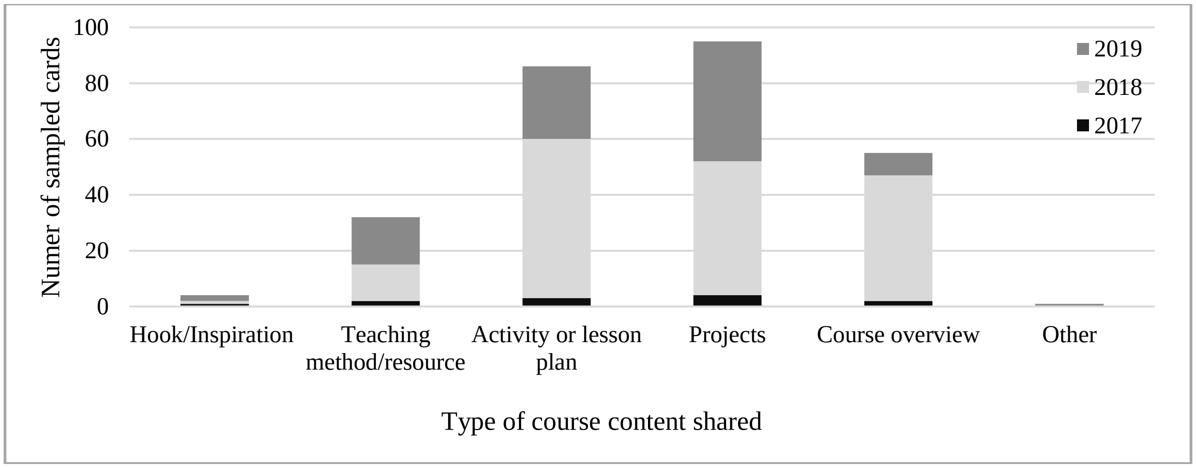

Figure 3: The number of sampled cards by types of course-related content each year

An additional variation between cards is the amount of time a card is expected to take inside or outside of the class time. The author read through the card descriptions, provided resources, and any author comments on the cards to try to determine the expected amount of time planned for each card, but many cards did not have any information. The results of these time considerations are shown in Figure 4. The largest group of cards were those that required one month or more of in-class time (30.6%), followed by cards that were designed to be a single-class infusions (27%). While more than 80% of cards specified the amount of in-class time required, only 60% included the amount of out-of-class time required. Including this information could increase use of existing cards. Of those that documented the required out-of-class time expected of students, most had either no time allocated (no homework and no course preparations) or required students to be working on the materials for 2 or more weeks. While there is some pattern between the types of course content and the expected amount of in- or out-of-course time, it is not a guarantee. As one example, some class activities require 1-2 weeks of student research before a single class period discussion activity, while a 4-week project might be completed exclusively during in-class time.

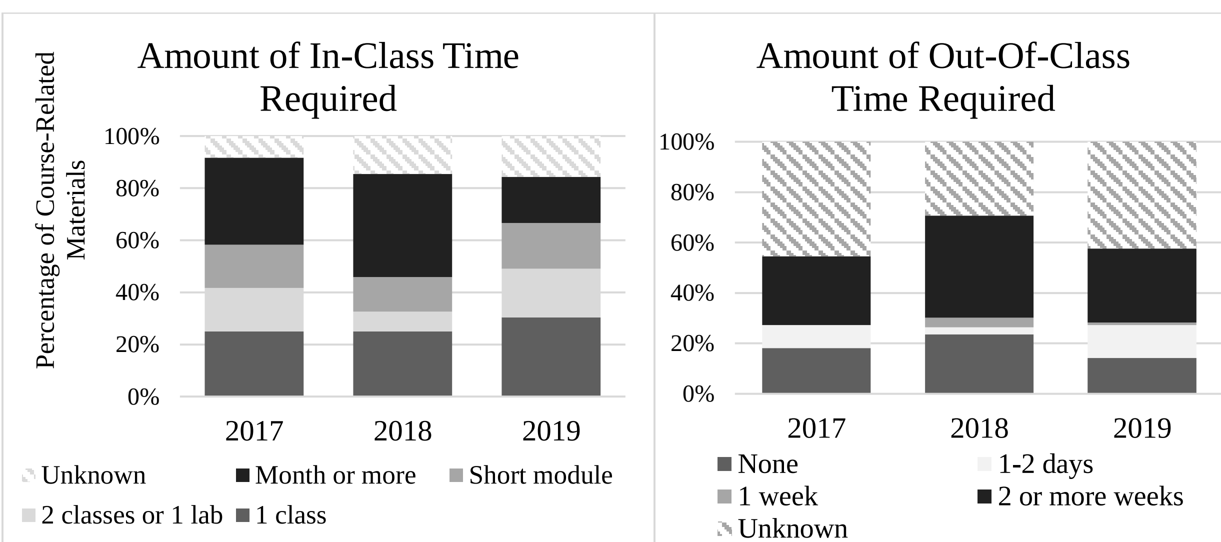

Figure 4: Amount of time required in-class (left) and outside of class (right) to complete classroom-related activities as indicated by sampled cards.

3.2 Single-class infusion card analysis and characteristics

From the 400 sampled cards and 272 classroom-related cards, only 67 cards were designed to be single-class infusions which would introduce EM skillsets and outcomes within a single class period of 90 minutes or less. Thirty of these cards were further analyzed to determine any shared characteristics. Table 1 shows what proportion of cards incorporated the six KEEN EM learning outcomes and complementary skillsets. The single-class infusions were more likely to claim student outcomes related to constant curiosity and making connections by integrating information. Both learning outcomes related to creating value were less-often included in single-class infusions of EM included in the analysis. All of the cards addressed multiple area of skillset development, with design elements being the most common and opportunity being the least. There is no limit on the number of learning objectives or skillsets that a card author can select on the platform, so many cards select multiple objectives. The best way to assess EM learning outcomes across courses and academic years is still being discussed and researched [18], so the extent to which all sampled cards are successful in helping students meet the various expected learning outcomes is not analyzed at this time.

Table 1: Percentage of sampled single-class EM infusions documenting incorporation of KEEN EM learning outcomes and skillsets

Entrepreneurially Minded Learning Outcomes	
83 %	Curiosity- Demonstrate constant curiosity about our changing world
47 %	Curiosity- Explore a contrarian view of accepted solutions
77 %	Connections- Integrate information from many sources to gain insight
33 %	Connections- Assess and manage risk
20 %	Creating Value- Identify unexpected opportunities to create value
37 %	Creating Value- Persist through and learn from failure
Complementary Skillsets	
80 %	Design
70 %	Opportunity
77 %	Impact

Possible arguments opposing the creation of single-class activities or lessons to incorporate EM may hinge on the idea that complex technical topics cannot be enhanced by EM within a single class period. To determine this, the author analyzed the target academic level of single-class infusions, the distribution of discipline-specific materials, and the type of activity proposed. While the majority (70%) of sampled cards were designed for first year students or general engineering and would not require technical background, 37% were designed for sophomore or junior level courses and 7% were designed for senior-level classes. This indicates that while possibly more challenging to create, it is not impossible to design single-class activities for upper-division students. The lack of cards related to senior-level courses may be because many of the topics covered in an EM senior-design class such as ethics or determining design requirements from clients are not tied to advanced technical knowledge and can be taught in a more general nature, outside of single disciplines.

While 63% of the sampled cards were focused on general engineering, many had direct relations to at least one academic discipline. Table 2 shows the number of cards relevant to each major

Table 2: Number of sampled single-class cards applicable to academic discipline

Applicable Discipline	Aerospace	Biomedical	Chemical	Civil	Electrical/Computer, Computer Science	Environmental	General engineering	Industrial and Systems	Mechanical	Physics or Math
Number of cards (max 30)	1	3	3	3	5	1	19	0	7	2

engineering discipline from the sampled 30 cards. As one example, Clark Hochgraf developed a single-class card that explores students' knowledge of Ohm's law while hypothesizing and testing voltage in various drinks including coffee, tea, and energy drinks [23]. While industrials and systems engineering specific topics were not found in the 30 cards analyzed, there are likely relevant cards not included in the small sample,

Figure 5 shows the number of sampled cards which incorporated various types of class activities. With 33% of sampled cards developing technical skills, faculty should not be afraid of trying to add EM learning objectives into a single class period as they can enhance technical skill development. As an example, Gohler takes his students to play yard games and uses technology apps to track angles- students end the class and course by comparing statistical analyses across sports and individuals [24]. As little as 10 minutes can change student perceptions of data.

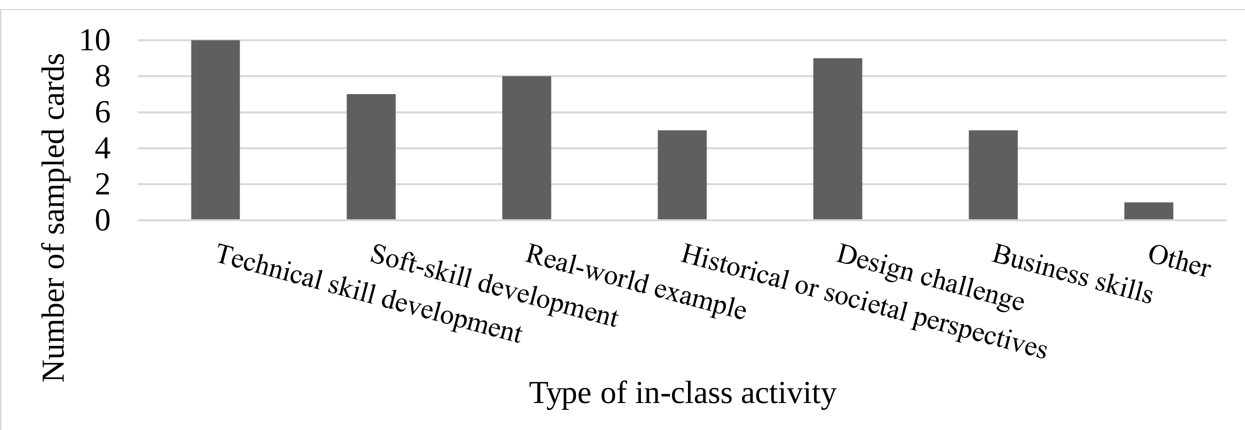

Figure 5: Number of sampled cards utilizing each type of in-class activity.

With all of these various activities, how do single-class infusions balance learning while still covering the material in less than 90 minutes? Some of them do this through pre-class assignments (13%) or as homework (23%). While many class ideas don't need the additional time before or after class to adapt a course to include the entrepreneurial mindset, it may allow faculty to introduce the content in advance and have students dive into the class materials in an exciting way during class time, similar to the methodology behind flipped classes.

3.3 Author thoughts on Engineering Unleashed cards

The author's attempt to categorize cards was not simple or easy. In general, it was observed that many cards included too broad a scope of materials to be helpful for someone looking for an activity easy to integrate into their class. Rather than providing one large module card with materials for multiple lesson plans, multiple assignment sheets, reading assignments, video clips, and reference publications (which can be overwhelming to try to sort through), faculty authors should consider creating multiple cards, documenting a single activity or lesson in each one, and then link them together with an overall card. This multi-card approach focusing on the individual class or activity level would likely increase transferability and make the topical cards more likely to be found when using the search function. The "Card Decks" are a similar approach to this method started by Engineering Unleashed, grouping and linking multiple cards of similar nature into a single location.

As another challenge, many of the cards posted to Engineering Unleashed that teach generic skills or activities that can be used across discipline boundaries are tagged with every discipline offered on the website, overpopulating the searches for those fields with generic rather than discipline-specific cards. This reduces the usefulness of the card search function. As an example, a discipline specific search such as "electrical engineering" will result in cards that teach interview skills for empathy that could be used by electrical engineers but is not a card that has already been applied to the field. Engineering Unleashed has since the time of this research created new tags for more general cards, but most existing cards have not been updated by the authors to reflect these new search functions- this is most relevant for cards moving forward.

3.4 Results of implementing four single class infusions of EM into a first-year engineering class

This faculty member found implementing all four single-class infusions of EM material easy to merge into existing course materials. Two of the modules (engineering economics and ethics) replaced existing class lecture materials for those topics in the course, reducing the need to find any additional class time to include the topics. The modules related to market analysis and product validation both acted as scaffolding for the final project, providing an opportunity to incorporate EM into the final project without expecting students to do all of it outside of class without guidance. Further suggestions for improvements and classroom implementations of the individual lessons are available online in the card for each lesson [19-22].

Students were assessed for the first three modules based on completion of in-class handouts or the short research report. However, because of the open-ended nature of all topics, students earned the majority of their points for documenting methodology and logical thought process rather than comparing their work to a correct answer. An example of the rubric for the engineering economics activity is provided in Table 3. Students received a copy of their grade for each of the first three assignments on a rubric similar to this one with the same major rubric categories across all three activities. Individual expectations were customized to each unique activity.

Table 3: Sample assessment rubric for a single-class engineering economics EM deliverable for first-year students

Rubric Category	Expectations
Complete Content	-1 page summary included, with appendix calculations -1/2 page risk statement from each student with appropriate topics
Formatting	-Professional document with proper grammar, citations, and labels
Curiosity	-Identified criteria that are relevant for city selection with appropriate research -Were creative in identifying various risk factor
Connections	- Integrated information from multiple sources to identify opportunities -Assessed and proposed solutions to a variety of risks
Creating Value	-Clear statement of why each city would be the best selection, even if not financially supported

As an additional measure of the overall impact of all four single-class infusions, students were asked to submit a short reflection documenting their favorite activity, as well as identifying which class activities, if any, they related to the three learning objectives of Curiosity, Connections and Creating Value. Ten students submitted their reflections, of which the summary results are shown in Table 4. Table cells are shaded to represent the primary EM learning outcomes targeted by the faculty member for each activity.

Table 4: Student responses indicating favorite activity and self-identification of EM learning outcomes for each single-class infusions of EM.

Lesson	Favorite activity	Identification of Curiosity	Identification of Connections	Identification of Creating Value
Economics	20%	60%	20%	10%
Market Research	20%	30%	60%	50%
Value Proposition	10%	20%	50%	30%
Ethics	50%	50%	50%	30%
None of the lessons	10%	10%	20%	20%

Note: shaded cells indicate the main EM learning-objective targeted by the faculty member in the design of each lesson.

Students indicated the ethics case-study as their favorite class; this is not surprising as not only did the class have no homework in comparison to all of the others, but it was also the most engaging in-class activity. Students reported they were most likely to develop curiosity with the engineering economics lesson, and both connections and creating value with the market research lesson. The student reflections of EM learning outcomes did not match the design of the lesson plans. While it is not a negative consequence to have students identify and develop curiosity in lessons that were not intended to do so, the link between the various lessons and the intended 3 C's (Curiosity, Connections, and Creating Value) may be strengthened if the faculty member had shared the KEEN framework with the class before each EM-infused lesson.

Tak found that students sometimes felt frustrated with the open-ended nature of self-directed learning styles common in teaching entrepreneurship [2]. By simplifying large projects down into smaller single-class activities and deliverables, students have less uncertainty within the scope of each deliverable and may be less frustrated by the new EM-infused lessons and activities that often promote individual student exploration of a topic, grappling with no-right-answer problems, and solving real-world problems or scenarios. Single-class infusions are one way to isolate and scaffold large projects into smaller deliverables, or even provide smaller practice opportunities in one context that the student can then apply in the final project.

4. Conclusions and Next Steps

This paper was motivated by the author's personal desire to find examples of classroom activities to adopt into their own class. However, preliminary usage of the Engineering Unleashed website often resulted in mostly irrelevant cards that had either too-much information to peruse with more than a dozen different attachments and lessons, or search results that has too many unrelated, generalized cards. Of the 400 sampled cards in this study, only 68% of them were directly related to coursework, and of those, only 24% took less than 90 minutes of in-class time to deploy. The analyzed sample of the single-class infusions, while small in number, highlight the vast opportunities and successes for incorporations of entrepreneurial mindset into a small amount of class time. Faculty-created cards showcase a variety of lesson content, as well as a mix of both general skills and technical discipline connections. Smaller activities designed to introduce or expand on EM can be infused into all academic levels of coursework from first-year general courses through technical core classes and senior design.

The author's creation and implementation of four single-class lessons into their own first year engineering class resulted in general student enjoyment, did not take a significant amount of time to incorporate, and enhanced student learning. However, additional work is needed to help students link the single-class EM activities in their class experiences directly to the learning outcomes associated with the KEEN entrepreneurial mindset model. Additionally, the assessment of how well a single-class infusion might impact student outcomes related to entrepreneurship or an entrepreneurial mindset, especially in comparison to more traditional methods, should be explored further.

As faculty continue to share their classroom pedagogy for EM on Engineering Unleashed, they are encouraged to reflect how easy it would be for another faculty member to navigate through their materials. Have the authors provided enough information such as the time required inside and outside of class to complete each activity? Would a large set of material be better organized if documented as individual class periods identified by specific topics of coverage? This emphasis on single-class infusions of EM helps the Engineering Unleashed community promote transfer of ideas between faculty, across institutions, and across disciplines, advancing the field of engineering education one single class period at a time.

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