Design Your Own Entrepreneurial Roadmap: A Four-Year Cohort Fellowship Model to Develop the Next Generation of Innovators

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Abstract

Solving todays' challenges requires engineers to find new ways of thinking – and acting. A growing number of engineering programs and students across the U.S. look to entrepreneurship training to foster those new pathways. Core constraints often get in the way – engineering curricula leave little room for new courses beyond the fundamentals, semester timeline constraints do not offer enough time for entrepreneurs to develop and test their ideas, new applied or experiential courses face faculty headwinds, and "acting" like an entrepreneur requires cross-department learning, like understanding financial viability and societal demand – typically understood through the lens of social sciences. This paper describes a new four-year cohort-based fellowship to overcome those constraints in order to develop and apply entrepreneurial mind and skill-sets to new engineering applications. Fellows access a flexible yet disciplined co-curricular pathway to explore and pressure test new ideas and ventures, understand systems, network and practically build and foster resilient organizations and communities. Fellows receive stipends, training, mentoring and opportunities to field test their ideas and ventures over their entire college career. Fellowship outcomes are assessed through coded analysis of student reflections and applying the EntreComp entrepreneurial competency framework. This paper suggests that the fellowship effectively helps students develop and field test creative vision, cultivate greater self-awareness and intrinsic motivation, take thoughtful risks, overcome challenges, and nurture teams and collaborative environments while birthing impactful new ventures and bolstering their engineering fundamentals.

Introduction

More than ever, the world needs innovative products, services and organizations to help society move forward. Those who will design these advances often seek opportunities in college to both develop and test new ways to solve problems in ever-growing ecosystems and new engineering applications. Though engineering programs often excel at teaching technical capabilities, communication, leadership, teamwork and project-based learning activities gain less attention. In addition, engineering programs typically lack a structured method to apply entrepreneurial thinking to their studies, where questions of financial viability, social usefulness and potential demand for their engineering solutions are integrated into their coursework. Therefore, co-curricular programs can provide these opportunities outside of the packed engineering curriculum while offering outlets for students to develop a growth mindset, build self-awareness, and learn to take initiative and build ventures in real-world settings.

Developing creative and dynamic engineers requires a multi-faceted approach to engineering curricula. Theoretical courses, hands-on activities, project based learning, teambuilding and leadership opportunities all need to be packed into an accredited curriculum. The challenge for all engineering educators is to provide sufficient and consistent opportunities for engineering students to explore new ideas and approaches, act upon those ideas and transform them into value for others

and themselves. A co-curricular training fellowship offers the skill-building, cohort-based peer-support, 8+ semesters of time, and life experiences to help address this challenge.

The rise in entrepreneurship education at the university level is rooted in student and faculty desire to teach abstract and applied STEM knowledge in a deeper way that delivers value for real-world stakeholders. Students learn dynamism and adaptability while simultaneously obtaining the fundamentals [1]. While entrepreneurship education typically rose out of business school roots, engineering programs increasingly look to integrate those activities in their curricula due to natural synergies around the design process [2], customer/product fit, student demand for purpose-driven work, self-efficacy, and measured risk [3]. Faculty have incorporated the entrepreneurial mindset [4], head/heart alignment and passion finding, creativity, and an innovators identity [5] into various elements of experiential and project based courses. Capstone design instructors often teach tenets of entrepreneurship to their design teams to build "soft skills" and develop "well-rounded" engineers [6]. These activities are both necessary for ABET accreditation as well as desired by the engineering workforce.

In addition, employers seek more creative, entrepreneurial engineering graduates. Increasingly, they believe that gaining knowledge beyond traditional engineering curriculum is more important than discipline knowledge [7]. In addition, learning creativity and applying those methods during the problem identification stage is key to creatively solving problems. Programs that focus on narrow or deep technical specifications risk producing engineers who are ill-equipped to tackle the problems sparked by increasingly rapid and dynamic change in society [8]. In fact, studies show that without intentional creativity instruction, we risk producing engineers who are less creative and less capable of critical thinking after completing their college education than when they began [9]. Thus, entrepreneurial opportunities that deeply engage the passions of students bring them out of their academic bubble and tend to produce high quality designs because they are intrinsically motivated to meet stakeholders' needs. [10]

Cornerstone/capstone courses in a project-based curriculum offer a more typical way to infuse entrepreneurship into engineering coursework. In general, teams that include creativity exercises exhibit greater innovation in their design process, both in first year design [11, 12] and final capstone experiences [13]. Interestingly, studies have measured no correlation between creativity and GPA using validated creativity indices [14], showing that technical academic achievement is not a pre-requisite for producing innovative engineers. Furthermore, student outcomes are positively affected by incorporating entrepreneurial activities into engineering curricula. Studies have shown marked increases in student retention and GPA [15] illustrating the positive role of cultivating the intrinsic motivation of engineering students.

Knowing the positive effects of integrating entrepreneurship activities, the question is: what is the best way to deliver and integrate them into existing higher education environments? Findings indicate that entrepreneurial knowledge grows with the number of entrepreneurship courses taken, as well as engaging in experiential learning activities [16]. Further, students in multidisciplinary programs tend to rate their entrepreneurial abilities higher than those programs embedded within engineering departments [16]. While entrepreneurship programs may not generate a greater population of innovators, they do tend to help students better identify their potential as entrepreneurs and improve the startup performance. [17]

Integrating multi-disciplinary entrepreneurship into engineering activities succeeds through interdisciplinary collaboration and student fellowship programs. Programs at Caltech [18] and Michigan [19] have shown that developing a culture of innovation in getting students from STEM backgrounds to "think like an entrepreneur" is possible by combining extensive mentorship, educational resources, and experiential project work. While these efforts were undertaken for post-graduate STEM students looking to commercialize research innovations, the same ideas and structures apply to undergraduate engineers in a co-curricular setting.

This paper describes and assesses the impact of an entrepreneurial fellows program organized by the Dyer Center for Innovation + Entrepreneurship at Lafayette College. Students with STEM majors represent a majority of the fellows. The cohort-based, four years program fosters and sustains a culture of innovation and entrepreneurship for select engineering students that increases their entrepreneurial capacity to lead and inspire change while strengthening their fundamental engineering training.

Fellowship Program Description

Believing that entrepreneurial thinking and action can be nurtured and taught among engineering students, the Dyer Entrepreneurial fellowship recruits incoming freshman applicants from diverse locations around the world, often first gen college applicants. Applicants submit essays describing their ability and experiences to overcome challenges, work in teams, find good ideas and start ventures. Individual interviews deepen understanding of their motivations and measure their communication skills. A team-based dynamic assessment offers insight into their teamwork, listening, and ideation skills. Ten fellows are selected as they finalize their decision to attend Lafayette.

The cohort based interactions of the fellowship begin prior to the start of the students' first year. Summer reading focusing on ideation [20] as well as preparation for their big transition [21] is assigned and discussed. When designing the fellowship, the guiding principle of creating psychologically safe places for teams to solve hard problems was emphasized throughout. The fellowship structures an environment for thoughtful discussions of entrepreneurial ideas along with college transition fears to help students acclimate to a competitive and collaborative environment that emphasizes growth and development, not static talent or IQ.

This is enhanced by a weekend-long, pre-college, team-building experience where students can bond over shared physical experiences and discussions. The students' transition to campus is further deepened by their involvement with our international students' orientation. Because the fellowship attracts many entrepreneurial foreign-born students, this supports their transition to college life in the United States. However, including domestic students in this orientation has the added benefit of immediately exposing them to diverse worldwide cultures and new ideas – a key attribute of successful entrepreneurs. The students deeply appreciate these pre-college experiences, both to aid their transition to a new environment as well as break them out of their pre-college bubbles. Additionally, the fellow's cohort and mentors become their extended family,

a network they count on for support and guidance and motivation for each other to continue to reach their goals.

During their first weeks on campus, each student finds a dedicated staff member to serve as an advisor/coach for their undergraduate career. These important meetings help students adjust to the academic environment, discover and improve time management skills, and learn to navigate (rather than be dragged along) their college experience. In order to break down the faculty/staff/student barrier, each student finds professors and staff members whose interests align with their passions. Experienced entrepreneurs, serving as "Entrepreneurs or Innovators In Residence" to the college play a key role, enabling fellows to see the links between their academic pursuits and their entrepreneurial passions. This personal coaching has been extremely effective over the first three years of the fellowship program, kick-starting students into high levels of engagement and ownership in charting their path. Students also meet with entrepreneurial peer leaders (typically junior or senior level undergraduate fellows) regularly to help navigate college life.

During the winter interim, fellows start an external professional certification program. Students typically select Google Certificates in Project Management, UX Design, or Data Analytics. Each requires around 100 hours to complete, offering students a significant accomplishment, resume-builder and skills. While these skills may be gained in the classroom, most courses which directly cover this content are upper-division courses or require pre-requisites, restricting entrepreneurial students of all majors to access that content. In addition, it stresses the second pillar, skill building, acknowledging that important ideas necessary for their journey lie outside the classroom and require perseverance to achieve. Students typically complete these certifications during the summer between their first and second years. Coursera also offers quality asynchronous instruction in important entrepreneurial skills.

During the second semester of their first year, fellows work on a project with a local non-profit agency. The experience offers fellows the chance to better understand the organization's mission and culture, approach to their stakeholders and community members, and delivery of their services/products to customers. The fellowship designs these internships to create lasting value for the partner organization – and a robust experience for the fellow. These interactions allow the fellows to develop the three remaining capabilities of the fellowship: think entrepreneurially for a worthy organization whose mission they find meaningful; work on a project that allows them to prototype their entrepreneurial skills including leadership, teamwork, adaptability, creativity, and emotional intelligence; and develop their networking skills within an organization where real deadlines and stakeholders matter. These projects reinforce that social entrepreneurship can be an engine of transformation [22] and a career choice for the entrepreneurially minded. Finally, this builds fellow resumes with

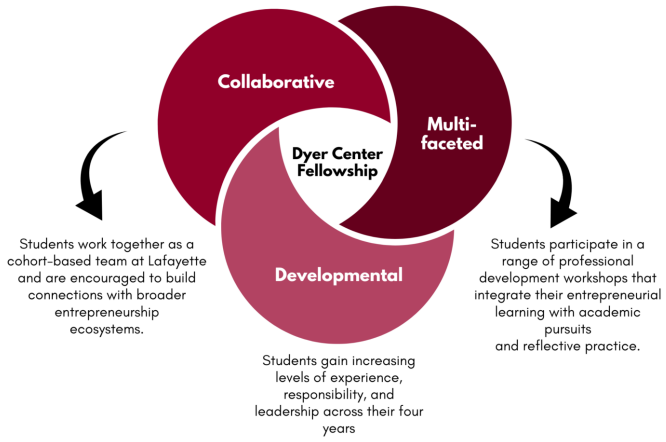

Figure 1: Construction of the Dyer Fellowship

meaningful activities and shows real growth to future employers.

The fellows' first year journey sets the stage for their college career. Fellows learn to achieve in a wide range of activities and capabilities that are developmental as well as collaborative (Figure 1). Each successive year brings increasing complexity, wider engagement with larger networks, more personal accountability, and greater aspirations. Each semester contains further intentional education and experiences where fellows explore their strengths and passions, identify and pressure-test interests/ideas in teams, enhance their creativity and maximize their extensive opportunities for growth.

The fellows' second year uses entrepreneurial "sprints" as a way for students to build on their ideas, nurture creativity, build networks, and see new opportunities to fruition. Students learn first-hand that entrepreneurs try new ideas as each attempt – and each setback - teach them how to construct a successful venture. Students are tasked with thinking creatively about something they want to put their entrepreneurial energies toward and are then actually doing this thing, seeing what it takes to bring this new idea to life. Some students fear creating a new venture from an idea. However, the same support systems built for their first year of the fellowship (the peer cohort, the faculty/staff mentoring, upper-class leadership and coaching) allow the students to feel well supported as they pursue their ideas and take risks. The Fall semester sprint focuses on new on-campus ventures while the Spring semester encourages teams of fellows to consider ventures in an environment where they are less comfortable – off campus.

Overall, the fellowship offers students a flexible yet disciplined pathway to develop growth mindset, systems understanding, networking and practical skills; the fellowship expects students to build and foster resilient organizations and communities during their tenure. Students gain increasing levels of experience, responsibility, and leadership across their four years. Starting with an internal assessment of their own values, interests and heart/head alignment, they learn to think like an entrepreneur, spend time with challenges they want to address and reframe problems as opportunities, harnessing creativity and grit, finding mentors and connections in their interested fields to drive change. They gain hard skills such as project/team management, financial acumen, systems thinking, communication, and data analysis through coursework, workshops, and external certifications. They pressure test their ideas and ventures in real world settings, including not-for-profit organizations, commercial enterprises, and their own organizations. In each case, fellows individually align to ventures that allow them to showcase their recently acquired skills and entrepreneurial passions. They spend 25-35 hours per month in training and practice, receive a monthly stipend and access a $4,000 professional development/seed grant.

Fellows expose and test their drive and intrinsic motivation to impact their world, as they are encouraged to apply a relentless focus on problem solving. Fellows bring high expectations, ambition and the humility to collaborate with others in authentic and respectful ways to achieve exceptional results. By their 3rd and 4th years, they are expected to build or contribute to ventures that couple their engineering skills and mindset to varied fields and interests, impacting diverse groups of people in the academic community and beyond. They also become "near peer" mentors to the underclass fellows.

Figure 2: The Five Pillars of the Dyer Fellowship

Each year of the fellowship is constructed to develop five key competencies through coaching, guided activities, and individual pursuits (Figure 2). During the first semester on campus, the students push to expand their boundaries, investigate their head/heart alignment, and develop a working model of their campus ecosystem and where they fit socially/academically/entrepreneurially. To help fellows investigate how they can align their passion with their academic journey, fellows do a deep dive into *Designing Your Life* by Burnett and Evans [23]. Fellows spend six weeks uncovering their passion and chart a draft pathway to achieve that goal. Additionally, during the first semester, students learn how to communicate their founder story, understand different mindsets, find mentors and learn approaches to analysis (e.g. design thinking, systems thinking, etc.). Each of these activities is undertaken both individually and during cohort meetings so students build a sense of community and shared knowledge. As they explore these tasks, they learn to think like an entrepreneur, reframing problems as opportunities, harnessing creativity to drive change, and finding mentors and connections in their interested fields.

The third and fourth years of the fellowship continue to stress the five pillars of the fellowship while allowing the individual students to pursue entrepreneurial activities that closely align with their passions and they are encouraged to create and pressure-test ventures aligned with their academic pursuits. In addition, they participate in internal and external pitch competitions and business accelerators as their ideas mature and require more capital investment. During these years, fellows increasingly tap the Dyer Center alumni network as young entrepreneurs interact with external coaches/investors to further assist in building their ventures. Additionally, older fellows give back by coaching and mentoring younger fellows in their journeys. A summary of the four year progression is shown in Figure 3.

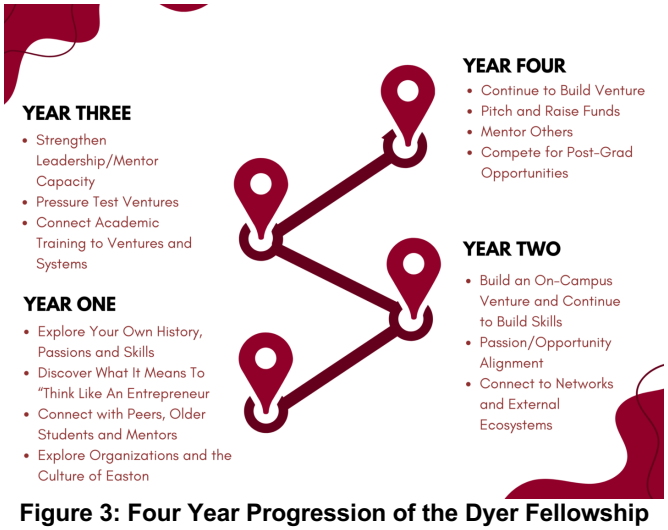

Figure 3: Four Year Progression of the Dyer Fellowship

The co-curricular fellowship offers financial incentives for all students.

Modest financial compensation for the time they devote to their entrepreneurial journey is similar to a 10-hr/week campus job. These funds allow the students to limit other campus employment activities in favor of developing their skills, ideas, and ventures. In order to remove further barriers for lower income students to pursue their entrepreneurial goals, fellows receive a professional development grant from which they can draw funds for approved activities: idea exploration, conference registrations and travel, equipment, participation fees, etc. This pool of funds allows the students to lean into their creative impulses to build small-scale prototypes, and network beyond their campus ecosystem. Students are obviously drawn to the financial aspects of the fellowship, but praise the freedom and unstructured nature of the professional development fund rather than the actual amount. Additional funds for venture development are accessible through the channels at the Dyer Center which are available to all students on campus. A summary of the main elements of the Fellowship can be found in Figure 4.

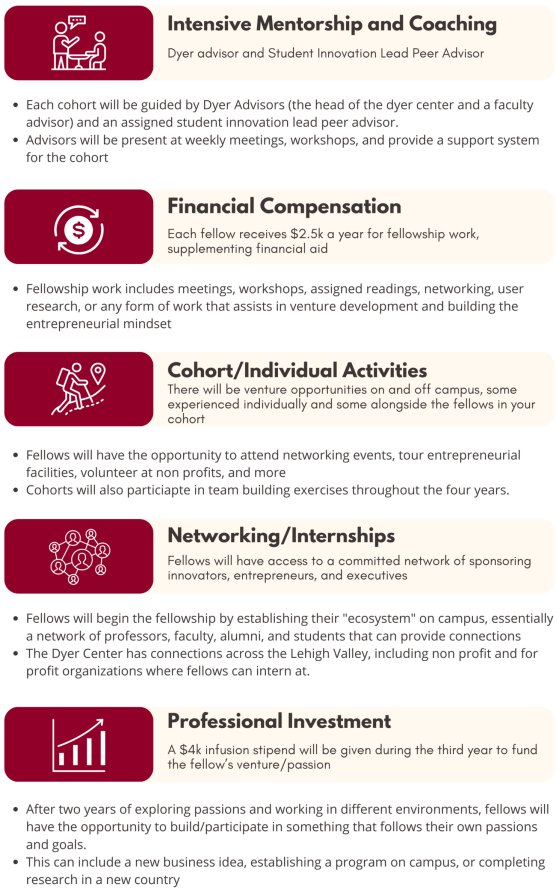

Figure 4: Main Elements of the Dyer Fellowship

The fellowship is not limited to STEM students, though a significant proportion of the students who are selected choose majors in science and technology. Of the twenty-five current fellows, seventeen are in STEM majors with fifteen of them enrolled in an engineering or computer science program. The fellowship admitted its first class in the fall of 2021, so the first fellows are now in their third year of the program. Despite the predominance of technical students in the fellowship, entrepreneurial interests range widely, including product based technical ventures, service based ventures focused on sustainability, and creation of non-profit organizations for social good.

Fellowship Program Assessment - STEM-Only Fellowship Student Survey

Fellows represent a wide range of majors (8 distinct STEM majors with 5 engineering disciplines represented) and class years (first, second and third year students). Thus, they exist at all points in the traditional engineering curriculum except the senior year. As a result, the below student reflections lack their senior year capstone projects and instruction. Because the students bring diverse journeys, the assessment tool utilized for this study relied on their own extended reflection. These students reflected on how their exposure to the core ideas and actions of entrepreneurship and innovation outside of the engineering/science classroom might influence

their interest in STEM, deepen intrinsic motivations, and improve their capacity to be better teammates and entrepreneurs.

In specific, students were asked to respond to the prompt:

Write a one-page reflection about how the Dyer Fellowship has influenced your STEM journey at Lafayette as well as how your classwork and focus on STEM has integrated into your entrepreneurial activities?

Of the seventeen STEM fellows invited to participate, fourteen responses were received (Four were third year students, six were second year students, and four were first year students). The following majors were represented: Mechanical Engineering (4), Electrical Engineering (1), Computer Science (5), Chemical Engineering (1), Environmental Science (2), Engineering Studies (3), Psychology (1). Three students seek dual STEM majors. Of the students responding, half identify as female and half identify as male. Because of the low number of respondents in the study, no attempt is made to dis-aggregate data based on class year, academic major, or gender identity. While detailed insights from such groups are certainly worthwhile to pursue, the current state of the selective fellowship with rather small numbers of student preclude meaningful statistical analysis of anything other than the whole.

To characterize the responses of the students, an entrepreneurial assessment framework was used. *EntreComp: The Entrepreneurship Competence Framework* was selected as this framework [24]. This type of framework has been shown to be effective in evaluating the effectiveness of entrepreneurial education in developing student capacities [25]. Both the students and Dyer Center staff are familiar with this entrepreneurial assessment framework as it is also used to assess the growth of the entrepreneurial fellows at the end of each semester, making characterization of the students' responses easier. For clarity, the EntreComp framework is shown in Table 1.

Table 1: EntreComp: The Entrepreneurship Competence Framework [24]		
Ideas and Opportunities	**1.1 Spotting Opportunities**	• Identify and seize opportunities to create value by exploring the social, cultural and economic landscape • Identify needs and challenges that need to be met • Establish new connections and bring together scattered elements of the landscape to create opportunities to create value
	1.2 Creativity	• Develop several ideas and opportunities to create value, including better solutions to existing and new challenges • Explore and experiment with innovative approaches • Combine knowledge and resources to achieve valuable effects
	1.3 Vision	• Imagine the future • Develop a vision to turn ideas into action • Visualize future scenarios to help guide effort and action
	1.4 Valuing ideas	• Judge what value is in social, cultural and economic terms • Recognize the potential an idea has for creating value and identify suitable ways of making the most out of it
	1.5 Ethical and Sustainable Thinking	• Assess the consequences of ideas that bring value and the effect of entrepreneurial action on the target community, the market, society and the environment • Reflect on how sustainable long-term social, cultural and economic goals are, and the course of action chosen • Act responsibly
Resources	**2.1 Self-Awareness and Self-Efficacy**	• Reflect on your needs, aspirations and wants in the short, medium and long term • Identify and assess your individual and group strengths and weaknesses • Believe in your ability to influence the course of events, despite uncertainty, setbacks and temporary failures
	2.2 Motivation and Perseverance	• Be determined to turn ideas into action and satisfy your need to achieve • Be prepared to be patient and trying to achieve your long-term individual or group aims • Be resilient under pressure, adversity, and temporary failure
	2.3 Mobilizing Resources	• Get and manage the material and digital resources needed to turn ideas into action • Make the most of limited resources • Get and manage the competences needed at any stage, including technical, legal, tax and digital competences
	2.4 Financial and Economic Literacy	• Estimate the cost of turning an idea into a value-creating activity • Plan, put in place and evaluate financial decisions over time • Manage financing to make sure my value-creating activity can last over the long term
	2.5 Mobilizing Others	• Inspire and enthuse relevant stakeholders • Get the support needed to achieve valuable outcomes • Demonstrate effective communication, persuasion, negotiation and leadership
Into Action	**3.1 Taking the Initiative**	• Initiate processes that create value • Take up challenges • Act and work independently to achieve goals, stick to intentions and carry out tasks
	3.2 Planning and Management	• Set long-, medium- and short-term goals • Define priorities and action plans • Adapt to unforeseen changes
	3.3 Coping with Uncertainty, Ambiguity, and Risk	• Make decisions when the result of that decision is uncertain, when the information available is partial or ambiguous, or when there is a risk of unintended outcomes • Within the value-creating process, include structured ways of testing ideas and prototypes from the early stages, to reduce risks of failing • Handle fast-moving situations promptly and flexibly
	3.4 Working with Others	• Work together and co-operate with others to develop ideas and turn them into action • Network • Solve conflicts and face up to competition positively when necessary
	3.5 Learning Through Experience	• Use any initiative for value creation as a learning opportunity • Learn with others, including peers and mentors • Reflect and learn from both success and failure (your own and other people's)

When examining student responses, individual statements could be categorized and grouped based on the EntreComp framework. Each meaningful statement was coded using the EntreComp framework both to classify the student's statement as well as see which of the categories was most often mentioned. The fourteen responses were sampled into 124 individual statements from fellows about their entrepreneurially influenced STEM journey. Then each statement was coded using the 15 individual elements of the EntreComp framework. Statements were coded up to three different framework competencies if warranted by the complexity and breadth. This led to 273 codes generated which could then be analyzed to see if there were themes among the fellows' responses. Potential themes were explored within the major groupings of the EntreComp framework: Ideas and Opportunities, Resources, and Into Action.

Fellow Statements - Ideas and Opportunities

The category of "Ideas and Opportunities" targets the student's ability to spot new opportunities, think creatively in developing those ideas, and project a meaningful venture based on those ideas into the future. These skills are difficult to teach in a traditional engineering context. Cornerstone and capstone projects are often pre-determined by external clients or faculty advisors and little emphasis is placed on truly understanding the customer or real-world impact of some design projects. Encouraging students in this area means creating space for engaged brainstorming and intentionally returning to that process often as students mature in their thinking. Three quotes from student reflections echo this idea:

> *The fellowship allows me to put STEM subjects into context, especially of business, and to understand the creative aspects, seeing how something goes from invention to the market has been a really valuable experience.*
>
> *Discovering the potential for real-world impact through projects outside of traditional classwork ignited my passion for learning.*
>
> *I think many engineering students go to class, but because class can be very abstract, they have no real direction when considering their future, applying to internships, or applying to jobs. In comparison, the Dyer Fellowship allowed me to critically examine what I care about, and how I can align those values with a potential career.*

These statements highlight the fact that entrepreneurial focused education allows students to better contextualize ideas and concepts discussed in class. Because they have carefully considered their direction through discussion and investigation of their academic passions, the fellows feel more capable that their peers in abstracting coursework into future ideas and creative pursuits. The statements also suggest a powerful feedback loop wherein passion for academic learning is reinforced by deeper understanding of how difficult STEM concepts can unlock future value.

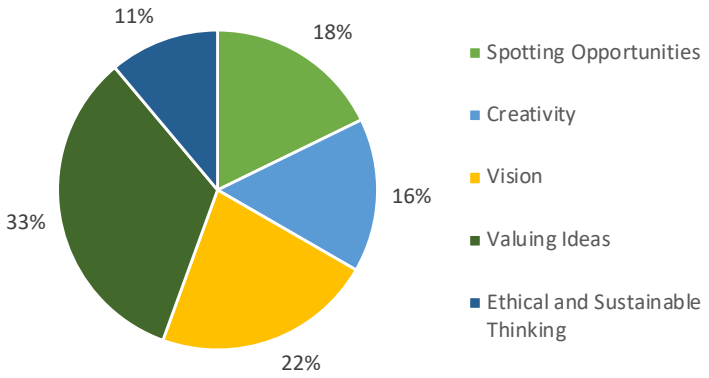

Figure 5: Ideas and Opportunities: ENTRECOMP Coding Evaluation of Students' Free Responses

When examining this category as a whole, fellow statements are well-distributed among the five competencies (Figure 5). However, statements that focused on valuing ideas and having vision were somewhat more prevalent. This suggests that the students are seeing value in the fellowship aim helping them discover their intrinsic motivation and pushing them to use that lens to examine new ideas and how they can best take advantage of them.

Fellow Statements - Resources

The category of "Resources" focuses on the students' ability to believe in themselves under difficult circumstances, mobilize physical resources for their success, and inspire others to join them. These skills are fundamental to successful engineering leaders and the projects they work on. Most engineering team projects allow students to develop leadership capabilities, communication competencies, and teamwork skills. However, these opportunities are often episodic (within the confines of a single course/project/term) and difficult to ensure that all students have had these opportunities in every team environment. The cohort model coupled with the individualized coaching of the fellowship drives students to confront issues related to motivation and self-efficacy within their major early and often within their academic career. In addition, working with the same teammates over several years on numerous projects and ventures allows the fellows to develop a deep sense of self and connection which amplifies their motivation and inspires others to work with them. Four student reflections highlight this idea:

> *The ability to communicate insights to teammates and stakeholders is equally crucial. The DYER Fellowship, through various opportunities, enhanced my ability to present ideas.*
>
> *I believe that resilience and self-motivation are other significant parts of entrepreneurship, and I was able to implement those skills into my STEM life.*
>
> *Through the fellowship activities, I am forced to confront difficult questions all the time. What impact do I want to have? What goals do I have for myself? What truly matters to me?*
>
> *Dyer Fellowship has allowed me to get right back up whenever I felt down. The weekly group and individual meetings helped me stay on track and believe in my ability to stay in the STEM field*

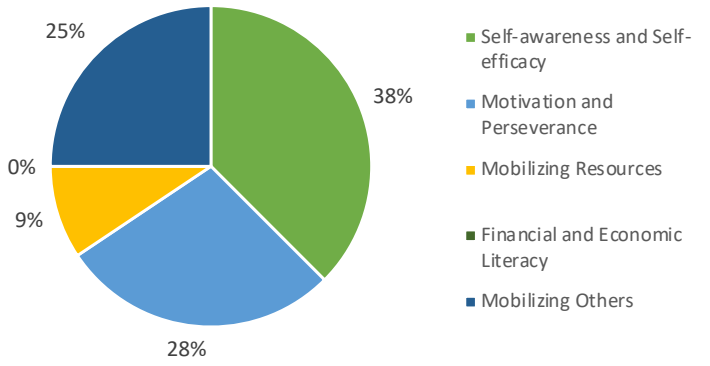

Figure 6: Resources: ENTRECOMP Coding Evaluation of Students' Free Responses

The fellow statements coded in this category predominately focus on self-awareness and self-efficacy, motivation and perseverance, and mobilizing others (Figure 6). This distribution is likely caused by the developmental nature of the fellowship and the focus during the first two years on exploration of self and the college ecosystem, passion/opportunity alignment, and connecting to local networks of entrepreneurially minded individuals. Students begin considering how to mobilize internal resources during the second year of the fellowship and external resources during the third. Thus, fewer students in this study have had the opportunity to explore this competency. Additionally, the individualized coaching and cohort based skills/passion inventory projects significantly grounds the student in their capabilities but also allows them to develop a growth mindset and resiliency. These traits are extremely important for persistence in STEM academic disciplines, especially for under-represented groups during the often challenging first year courses.

Fellow Statements – Into Action

The category of "Into Action" highlights the students ability to begin pressure testing a venture idea, plan the way forward, and work/learn with others to create value. This final set of competencies are what engineering design and laboratory team projects work towards. ABET student outcome #5 [an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives] directly points at these same ideas of putting engineering knowledge into action. While it can be hard to build this environment for undergraduate engineering teams, well-constructed project based learning opportunities might accomplish this. However, these are usually provided within specific curricular chunks (capstone/cornerstone experiences, qualifying projects) that typically do not range beyond a single term. The benefit of the continuous skills development and employment through the cohort activities and external internships/partnerships enables students to see the need for these additional competencies beyond their engineering coursework. Three reflections highlight this idea:

> *My software engineering class is entirely about project management and working in teams, and I feel I have covered a lot of it already through my Google Certificate and in general, working with fellows and on other projects.*

> *The culture of the fellowship that focuses strongly on collaboration has made me push for it in other environments (class, research, etc.) where it may not be nurtured as much.*

I transcend the role of 'just a technician' or a student studying computer science; instead, I am bestowed with the transformative opportunity to learn, passionately express my ideas, and embark on entrepreneurial ventures.

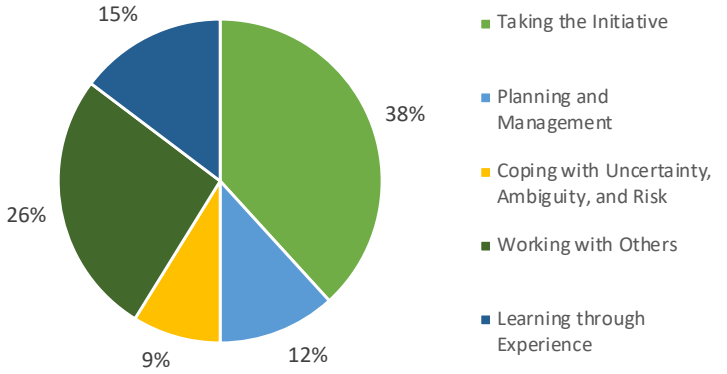

Figure 7: Into Action: ENTRECOMP Coding Evaluation of Students' Free Responses

Two core competencies dominate the "Into Action" category for engineering teams – taking the initiative and working with others (Figure 7). During cohort and entrepreneurial sprint activities, fellows take up significant unstructured challenges and work to achieve their goals. In addition, they continuously reflect on their successes/failures in their academic and entrepreneurial ventures. This reinforces the "learn by doing" concept that all hands-on engineering curricula aspire to. Since these competencies are stressed in the first year of the fellowship, fellows are very sensitive to seizing the initiative in their STEM group projects.

In addition to examining student reflection statements in different competency categories, it is also useful to examine the fraction of students whose statements align with the EntreComp categories. This metric is a proxy for the fraction of fellowship students who meaningfully achieve the outcomes associated with these competencies, sufficient enough to discuss them in their reflections. The results of this analysis is shown in Figure 8 for the 14 students who participated in the written reflections. Similar trends are seen in the frequency of fellows mentioning the competencies shown in Figures 5 – 7. There are strong responses (> 50 %) of the students in most categories. Most notably are the strongest responses in the competencies of "Valuing Ideas", "Self-Awareness and Self Efficacy", and "Taking the Initiative". Students participating in the fellowship program have seen strong growth in the ability to take up challenges and work to achieve goals, stick to intentions and carry out planned tasks. More importantly, they have developed the ability to believe in themselves and keep developing their entrepreneurial skills and identity despite uncertainty, setbacks and temporary failures. The repeated reflection on fellowship activities appears to have positively affected students ability to inventory their strengths and weaknesses and continue to build a growth mindset. These skills associated with persistence, tenacity, and grit are extremely hard to teach. The experiential nature of the fellowship with repeated challenges tackled in the cohort model appears to strongly influence this development in students. While it is possible students who apply for an entrepreneurial fellowship prior to entering college may already have some of these skills, the involvement with the program appears to strengthen these capacities and infuse them over a very large percentage of the students.

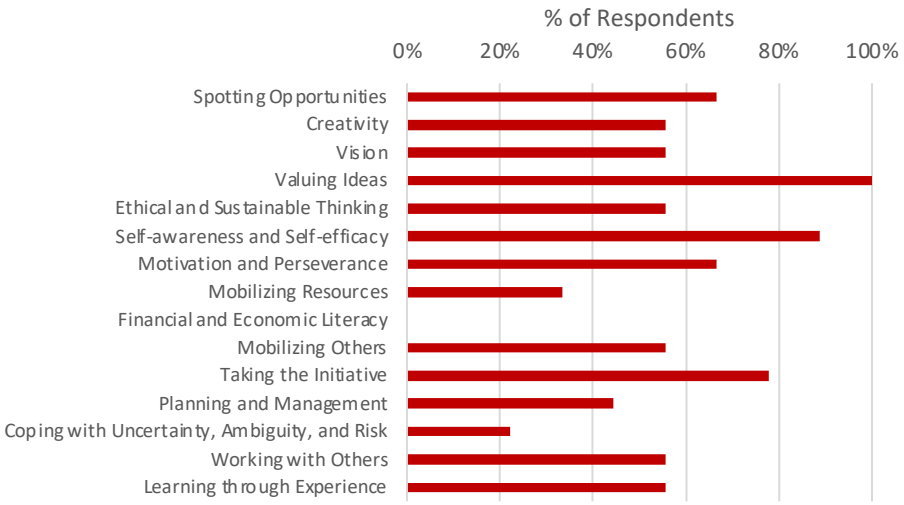

Figure 8. Percentage of Fellowship STEM students whose statements correlate with individual EntreComp competencies.

Fellowship Program Assessment - All Fellowship Student Survey

In addition to the data collected from the student in the fellowship who are enrolled in STEM majors, an extensive survey was administered to all 23 fellows in the Spring of 2024 with 21 responses evenly distributed among the 3 current cohorts. The survey contained both Likert style quantitative responses as well as long form answers to qualitative questions. Students were asked to quantify how effective they found each of the fellowship activities (scale 1-10) in shaping their entrepreneurial journey and furthering their educational goals. These activities included coaching, mentoring, workshops and networking opportunities, and team bonding sessions. The results are shown in Figure 9. For clarity, the vertical scale is shown between the ratings of 5 and 10 whereas the survey allowed responses from 1 to 10 (10 being the best).

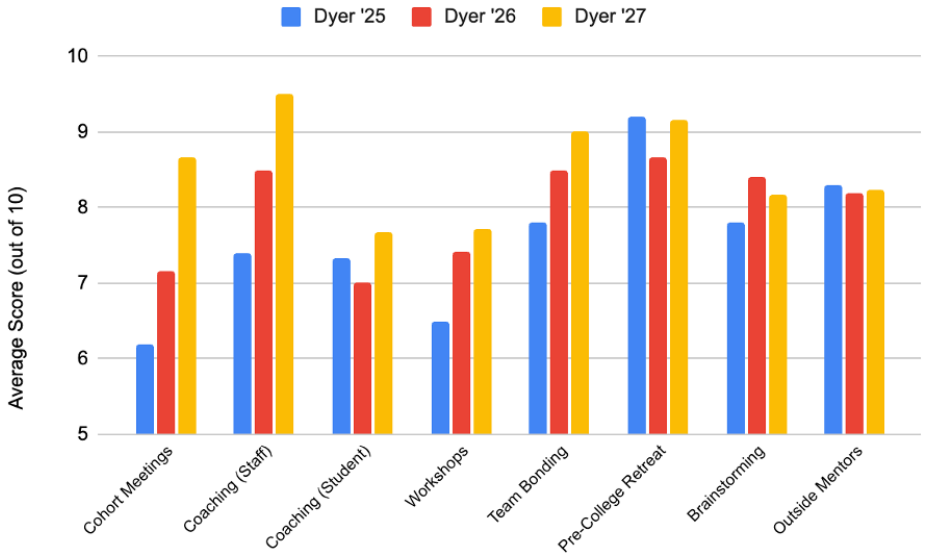

Figure 9. Averaged results from Spring 2024 fellowship survey grouped by cohort.

From the responses, the fellows are positive on each area of the fellowship they were asked to evaluate. However, some interesting variations can help guide the continued development of the fellowship. For example, a significant difference exists in the response to cohort meetings between the three cohorts, with the oldest cohort providing a slightly higher than average rating (just above 6) as compared to the younger cohort (nearly 9). This reflects the highly structured nature of the first year of the fellowship and the high value that the cohorts derive from it. As students progress to the second and third year of the fellowship, their cohort meetings are more evenly split between sharing operational learnings from their sprints and ventures with other students and instructional content. Pedagogically, the cohort meetings are important to reinforce the collective journey and network that the fellows share. As a result of the survey, we began having the older cohorts meet at the same time to provide more opportunities for interaction and sharing of ideas as they progress in their ventures. As the cohorts mature, there is a major opportunity to rethink how these activities evolve and better engage the fellows. As one Dyer '25 member said, *"I love my cohort but I wish it was a stronger influence. Though our connection with each other is strong and we're very comfortable with each other, we don't discuss anything much about our entrepreneurial journeys. We help each other with our ventures but that is usually as entrepreneurial as it gets."*

One of the major positives of the survey is the response that students have to the one-on-one coaching provided by the Dyer Center staff. Since January of 2022 (halfway through the first year of the first cohort), the fellows have had regular meetings with a consistent set of mentors. When asked what aspects of the fellowship individuals valued the most, 76% of the fellows highlight their regular mentoring meetings which provide a sense of direction, accountability, and a point of reflection to their entrepreneurial journey. Students are also very positive on outside mentors for additional viewpoints, networking, and frameworks. These have also been a stable group consisting of entrepreneurs and innovators in residence at the Dyer Center. Their regular presence in the fellows experience provides real value in helping them view their creative landscape and ecosystem.

Other aspects of the numerical survey are also illuminating. Students appreciate peer mentoring, though not as much as Dyer staff or outside mentors. The pairing of fellows two years apart in a peer mentorship capacity may improve this as the older students can focus their effort on a single fellow. Activities which strengthen the cohort bond (brainstorming events, pre-college retreat, and team bonding) are also seen as highly valuable in building trust and psychological safety. Finally, workshops held just for Dyer fellows tended to rate the lowest. This may be due to existing workshops not meeting the diverse interests among the fellows or providing enough individual value as compared to direct coaching or cohort activities.

In the same survey, students were also asked long-form response questions regarding the fellowship. The themes that fellows value the most include:

- Networking – both within the campus ecosystem and alumni networks
- Coaching – planning out academic, social, and entrepreneurial goals at Lafayette with trusted mentors
- Reflection – journaling to consider future direction
- Skill Development – both learning during cohort meetings as well as the Google Certificates
- Sprints – getting the opportunity to fail

The themes associated with what fellows feel can be most improved include:

- Connections between cohorts
- More practical workshops aligned with student interests
- More sprints, including members of multiple cohorts
- More networking, especially off campus partners and more aligned with each student's interests

Student Quotes from January 2024 Survey

How has Dyer influenced you?

I started a business, collected as many skills as possible! (graphic design, website work, side hustle community, accounting, marketing), expanded my mind, had the opportunity to constantly collaborate with others, and am actively making a change on campus

I hardly understood the principle of networking. I personally though it was a waste of time but now I believe it is the key. I did not get involved much on campus because I focused on my grades a lot, but DYER helped me widen that lens, try new things, and meet new people/groups.

The fellowship has allowed me to work on my own self-reflection skills, which in the long run has helped me improve myself. It has also helped me become more confident and motivated to reach out to people and ask questions, instead of holding back because I may not have enough experience.

What Are some of the most valuable aspects of fellowship?

The mentorship session and Dyer fellows meeting are the highlights for me. The Dyer Program's impact is truly shaped by the remarkable individuals within it. I am particularly drawn to the diverse array of students in the program, each bringing unique perspectives and wisdom to the table. This diversity creates a vibrant learning environment where ideas are shared, fostering collaboration among us.

I find that the network within my cohort and Dyer mentorship has been the most valuable aspect of the Dyer Fellowship. Speaking with members of my cohort and mentor has helped me create and work towards both academic and entrepreneurial goals.

Especially in my first two years, the Dyer Fellowship helped me think critically about what I care about and what I wanted to spend my time doing at Lafayette and beyond. Promoting those discussions and instilling this entrepreneurial spirit in me has given me the foundation to be more independent in the second two years of college and do all the cool things I've been able to be a part of.

What does it mean to be an entrepreneur?

The Dyer fellowship has changed my perspective on entrepreneurship. At first, I thought it to be simply business and managing finances, but the fellowship allows me to recognize the skills one needs to be an entrepreneur, and how you can be an entrepreneur with any kind of motivation, not just profit.

The impact on my life has been profound, particularly in the academic realm where I've not only received valuable guidance and feedback on assignments and courses but also experienced pivotal mentorship over multiple semesters. This mentorship has played a crucial role in enhancing my entrepreneurial skills, empowering me to actively participate in student-led ventures. Attending various events focused on ventures and startups has provided me with diverse perspectives on problem-solving and opportunities for improvement within our entrepreneurial endeavors.

It has helped me understand the two keys that make successful entrepreneurs. It has helped me understand entrepreneurship is not only about ventures but is a mindset that could be applied everywhere. And it has given me a framework to keep exploring entrepreneurial pathways.

What is the importance of having many voices within the fellowship?

Engaging in one-on-one meetings with career entrepreneurs has proven to be immensely rewarding for me. It serves as a platform where I can share my updates, and seek valuable guidance on optimizing the resources at my disposal. Throughout the various semesters in which I've had the opportunity to meet these individuals, I find that each interaction leaves me with new insights and knowledge. These meetings have created a strong sense of having a dependable support system within the Dyer Program, offering me the encouragement needed to pursue my passions and forge entrepreneurial pathways through meaningful connections.

I really like the workshops and lessons provided by our Innovators- and Entrepreneurs-in-Residence. They all bring a super unique and exciting energy to the space, and every time one of them comes and goes there's a real motivational energy in the air.

I think that the mentorship aspect of the program is one of its greatest strengths because it helps provide guidance that sometimes is lacking in college life. I think it can help each fellow to channel their strengths into paths where they can learn and grow.

Conclusions

The four-year, highly experiential developmental entrepreneurial fellowship was constructed to develop drive and intrinsic motivation among the participating students to relentlessly focus on problem – solving to impact their world and expand their career options. Through intensive mentorship, guided activities, entrepreneurial sprints, non-profit experience, and venture creation,

the fellows learn to bring high expectations, ambition and humility to collaborate with others in an authentic and respectful way to achieve exceptional results. They learn to think like an entrepreneur, understand systems and their components, reframe problems as opportunities, harness creativity to drive change, and find mentors and connections in their interested fields. Fellows also gain hard skills such as project/team management, financial acumen, systems thinking, communication, and data analysis through coursework and external certificates. Then, they pressure test their ideas in real world settings. Applying the EntreComp entrepreneurial capacity framework, an early assessment of the program shows that the fellowship successfully allows students to develop their creative vision and innovative thinking in the design process, generate stronger self-awareness and intrinsic motivation, learn how to take initiative, build successful teams and new ventures.

Acknowledgments

This development of the fellowship is generously supported by the Dyer Center for Innovation + Entrepreneurship and Lafayette College.

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