Exploring Opportunities for Innovative Professional Impact: Implementation of a Multidisciplinary Course

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Abstract

Engineering programs offer programmatic opportunities for students to develop the necessary knowledge, skills, attitudes to be prepared as holistic engineers for professional endeavors. Students have numerous career choices available to them after graduation, and there is an opportunity to teach students how to navigate these options and make decisions that align with their professional and personal values and goals. This paper describes the implementation of a new course entitled Pathways to Impact offered at a large university that was created with the formal objective of exposing students to various professional pathway options and decision-making considerations. This course serves to enhance student confidence in understanding the different ways in which they can make an impact throughout their careers, all while creating a learning experience that aims to strengthen students' entrepreneurial mindset. To achieve this objective during the first offering, this course utilized active learning techniques, personal reflection, and the development of an individualized career-impact roadmap by each student. In order to work in conjunction with programming available from existing career centers and academic advising, this interdisciplinary course placed an emphasis on personal reflection and the roles of innovation and technology commercialization in creating societal impact. This paper describes the logistics of developing and implementing this 1-credit hour course and provides details of the assignments used to assess student learning. This course can serve as an example to other institutions who seek to more fully empower their students to understand various career pathways—including through new venture creation, industry, or research and academia—and make career decisions that align with students' personal values and goals.

1. Introduction

Each year, thousands of undergraduate and graduate students graduate with degrees in engineering and science fields. Most academic institutions provide a variety of curricular and co-curricular opportunities for these students to expose them to the many career paths that are available to them. This paper provides an overview of a new 1-credit hour course at the University of Illinois Urbana-Champaign that was developed to introduce students to different career opportunities. Beyond exposure to various careers, it was also designed to provide a curricular opportunity for students to personally reflect on their professional goals, how they might make an impact throughout their careers, and the avenues in which they can do so.

2. Course Background

TE 498: Pathways to Impact was first offered during the Spring 2023 semester as a one-credit course available to upper-level undergraduate students and graduate students. The course was developed through the Technology Entrepreneur Center to teach content directly related to the entrepreneurial mindset as defined by KEEN [1] and introduce students to multiple avenues of professional impact, including technology commercialization. Course development was supported by the Kern Family Foundation as part of SIIP in The Grainger College of Engineering at the University of Illinois Urbana-Champaign and the NSF I-Corps Hub-Great Lakes Region.

The course was open to all students and most who enrolled were in STEM-related disciplines. This first iteration of the course had 15 students, although the intention is to increase enrollment in subsequent offerings after the content was piloted, assessed, and refined. This course was designed to provide students with a set of tools to understand the role of innovation in STEM and how to structure their academic and research-related activities and goals to focus on generating impact, whether on a micro- or macro-level. The course also focused on reducing misconceptions about innovation and entrepreneurs/intrapreneurs to aid students in understanding their potential role as inventors and innovators within their respective fields. To summarize the course purpose, students were given this overarching description:

> The purpose of this course is to introduce students to various professional pathways in which they can create and deliver impact and value for stakeholders. Students will explore career opportunities both in and out of academia, develop a set of tools to understand innovation and the impact of knowledge generation within various pathways, and reflect on their role as inventors and innovators within their fields.
>
> You will have the opportunity to see the depth and breadth of pathways that may be accessible from your knowledge and areas of expertise.
>
> This course advocates for your development of vital skills that can be enhanced by learning. You enhance your skills by becoming proficient with a set of techniques and developing a mindset that favors impact generating behaviors [aligning with the KEEN 3Cs]. It is expected that you will attend every class, participate in discussions and activities, and complete the assignments to the best of your ability.

The learning objectives of the course included that upon completion of this course, students would be able to:

1. Apply a variety of frameworks to view their research and educational goals.
2. Detect and assess atypical professional development opportunities.
3. Define the entrepreneurial mindset, and understand how it can help guide their research, educational goals, and career.
4. Explore–through outside stakeholders and their own community–how their research discoveries and knowledge might be implemented for societal impact.
5. Gather examples of citizen science and its impact.
6. Create a plan to make their educational and career objectives be more use-inspired and impactful.
7. Explain the pathways to impact within their own field of study and research area and how their discoveries could lead to societal impact.
8. Manage psychological barriers and conceptual misunderstandings about innovation that prevent individuals from seeing themselves as inventors, innovators, and entrepreneurs.

Class sessions were 50-minutes in length and met once a week throughout a 16-week semester. Lectures were structured to promote active-learning through brief warm-ups, frequent discussions, and in-class activities that promoted small group collaboration. The instructors promoted an inclusive, safe environment in which students could share with peers their thoughts and trepidations about their professional careers. This was done through write-pair-share

discussions and activities, personal examples of professional successes and failures shared by the instructional team, and allotted time for questions and comments.

Guest speakers who were experts in specific areas were utilized for multiple class sessions, including: the lectures in understanding personal values (faculty member in education) and how context influences innovation and impact (faculty member in engineering); an informal discussion with an academic professional from the university's career services center; a workshop by the university's leadership center staff after students completed the CliftonStrengths evaluation; and a panel of industry professionals. The first iteration of the professional panel included a patent attorney and an associate director of entrepreneurship and technology commercialization for a large university. Additional course topics and an overview of assignments can be found in Table 1.

Week	Lecture Topic	Assignment
1	Introduction to the course	Student Questionnaire
2	Personal experiences of developing impact	Pre-class Activity 1
3	Pathways to Impact mindset (based on KEEN 3Cs)	Individual Reflection 1
4	Furthering our understanding of impact What is peer teaching?	Pre-class Activity 2
5	Exploring and teaching about innovation leaders and their impact	Peer Teaching Lesson
6	Connecting values and interests to goals for professional impact*	Pre-class Activity 3
7	CliftonStrengths workshop*	CliftonStrengths Assessment
8	Impact through technology commercialization	Pre-class Activity 4
9	PEST & PESTLE analysis Introduction to the Grand Challenges [3]	Pre-class Activity 5
10	Exploring campus career services	Pre-class Activity 6
11	Impact Portfolio worktime	Individual Reflection 2
12	Innovating in context*	Pre-class Activity 7
13	Professional impact panel*	Pre-class Activity
14	Course reflection and next steps	Workbook submission
15	Finals Week (no class)	Impact Portfolio

** indicates content delivered by a guest speaker*

Table 1. Course lecture topics and assignment overview.

Most weeks, students were prompted to complete a warm-up at the beginning of class with instructions projected in the front of the classroom. Similarly, the last five minutes of many classes were reserved for an individual cool down activity. Students were asked to write their responses in the provided course workbook. Table 2 provides an overview of some of these activities.

Week	Warm-up	Cool Down
2	Write-pair-share of concerns of professional future	Futurist activity by imagining the impact the student has had in their field in the year 2050
2	Development of a mind map that connects interesting careers, skills needed, skills acquired, and exciting aspects	Connecting the KEEN 3Cs to concerns and fears of their professional futures
3	Open-ended reflection from previous week's KEEN Card activity	Peer Teaching Day topic brainstorming
5	Surprising, insightful, or useful things learned from Peer Teaching Day lessons	Preparing for CliftonStrengths by reflecting on previously completed self-assessments
7	Top takeaways from CliftonStrengths assessment and reflection on how this self-knowledge might connect with thinking about future professional impact	
9	Reflection on any prior knowledge of the Grand Challenges and what these challenges might be	
10	Compilation of any jobs the student has ever had, no matter the length or whether it was paid	
11	Main takeaways from previous week's guest speaker	
14	Write-pair-share of most impactful course takeaways	List of personal next steps after the conclusion of the course

Table 2. Summaries of class session warm-up and cool down activities.

3. Alignment to KEEN Framework

The course instructors sought to align lectures, activities, and assignments with the KEEN 3Cs: curiosity, connection, and creating value. This was done by utilizing the KEEN entrepreneurial mindset framework [1], which prepares students to:

- Recognize and identify opportunities
- Focus on their impact
- Create value in any context

Table 3 provides an overview of various activities and course topics and how the course instructors mapped them to the 3Cs. The primary objective of this mapping exercise was to ensure that students were receiving a wide breadth of content that sparked their curiosity, demonstrated the connection between various disciplines and careers, and provided insight into how to create tangible value (i.e., impact) through their professional endeavors.

Course Activities and Specific Topics Covered within Lectures	Week Covered in Class	Curiosity	Connection	Creating Value
Activity: Mind map of 10-15 potential career paths	2	X		X
Activity: List and discuss concerns about professional future	2	X		X
Activity: Mapping professional impact [2]	3		X	X
Activity: Personal SWOT analysis	4		X	
Activity: Assessing your personal values	6	X		
Topic: customer discovery	9			X
Topic: Stakeholder assessment	9			X
Topic: Technology transfer	9		X	X
Topic: Technology commercialization	9		X	X
Topic: PESTLE framework [3]	10	X	X	X
Topic: Addressing Grand Challenges	10	X	X	X
Topic: Contextual Engineering and context-based innovation	13	X	X	X
Activity: Professional panel with career pathways discussion	14	X	X	X

Table 3. Example course element alignment to the KEEN 3Cs as indicated with "X".

4. Workbook and Impact Portfolio

Pathways to Impact was structured as a letter grade course and student work was evaluated and assessed by the instructors. The course included many activities and brief pre-class assignments, but two main deliverables were used to assess student growth. The first was a workbook that was printed and given to each enrolled student (titled "My Pathways to Impact Journal") and the second was an assignment entitled the Impact Portfolio. Each of these assignments were worth 15% of the final grade. Students were asked to write in their workbook as their primary place to take notes and record reflections throughout the semester. An editable PDF version was also available to students upon request. Figure 1 provides a visual of the class note sections that was repeated for each class period (i.e., module). Figure 2 includes examples of pages at the end of the workbook that students were encouraged to add to periodically throughout the semester.

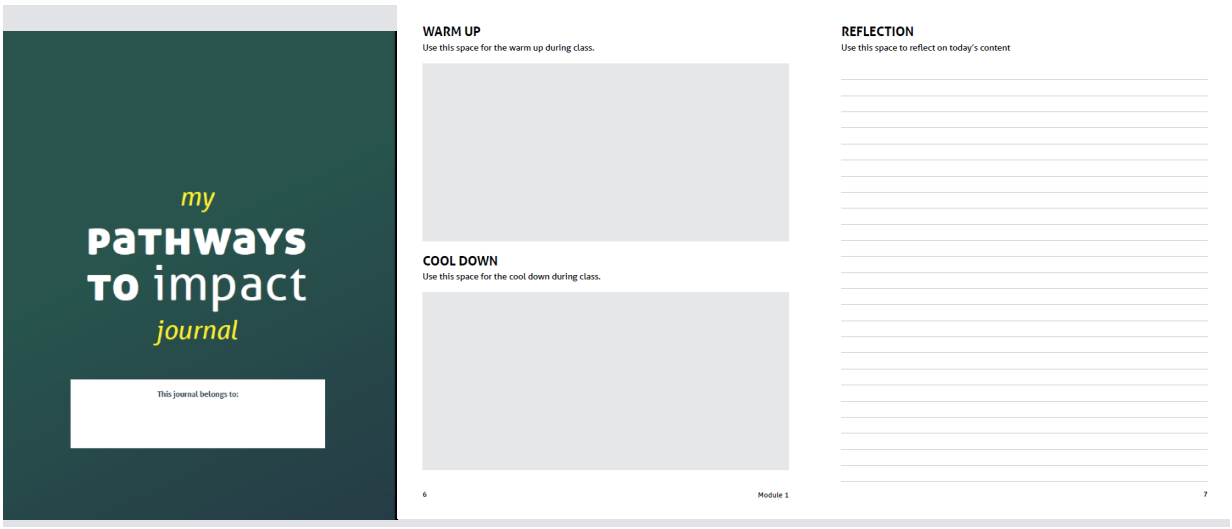

Figure 1. Workbook cover and example of sections that were repeated for each class period.

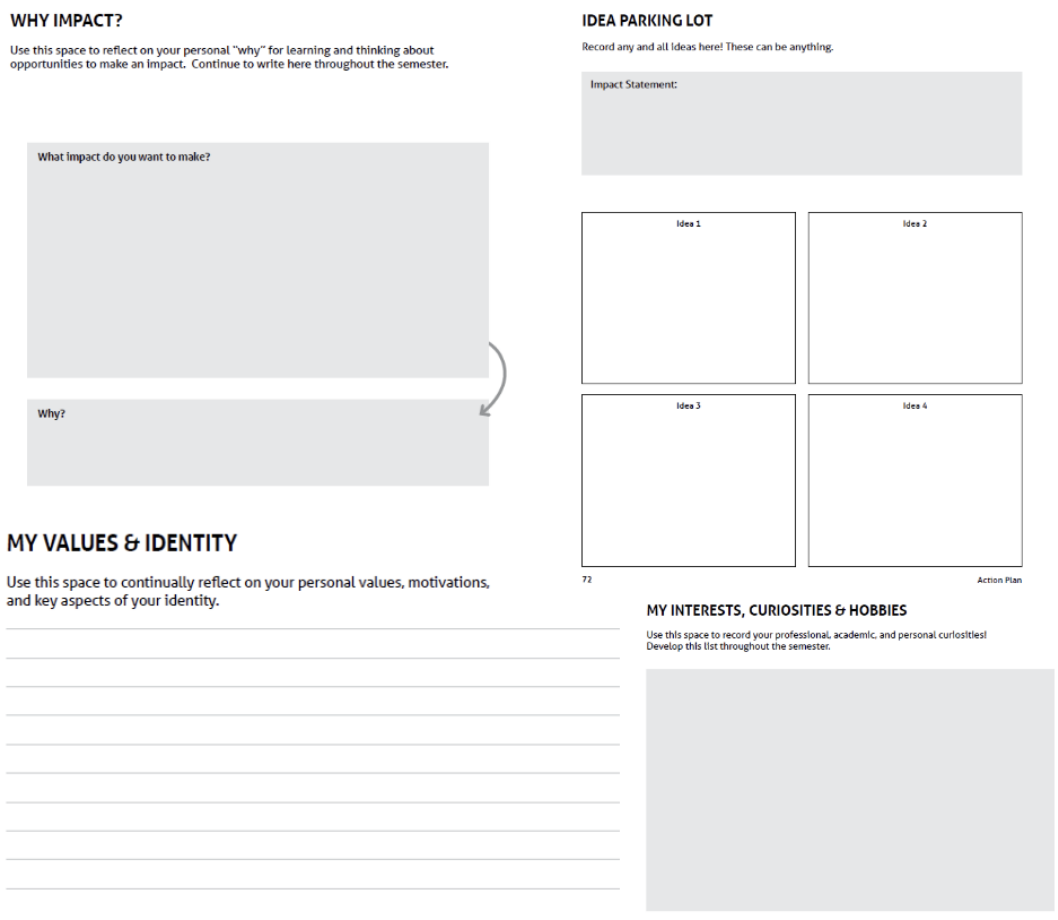

Figure 2. Examples of open-ended sections of workbook.

The Impact Portfolio included four distinct sections, three of which explicitly connected to the KEEN 3Cs. The curiosity section asked students to find a video and article that connected with their professional interests and provide a summary of main takeaways and connection to their overall interests and goals. A section emphasizing connections required students to identify one sustaining and one disruptive innovation in their field of interest, the innovation process the creator(s) took to implement, and the impact the innovation has had on the specific field and society. The creating value section asked students to include a one year and a five- to twenty-year plan for their potential pathways to professional impact and was based off activities found in one of the course readings from *Designing Your Work Life: How to Thrive and Change and Find Happiness at Work* [2].

At the conclusion of the Impact Portfolio, students were asked to write a multi-page reflection to address the following prompts:

- How has this course broadened your perspectives regarding future careers? Please discuss.
- What would you consider the most salient component/module of this course? Why? Please discuss.
- Describe two goals you have regarding your professional growth that you can accomplish by the end of this year. Create a brief monthly timeline with key milestones.
- What were your four CliftonStrengths areas? Describe how knowing this might help your interaction on teams or make career decisions.

5. Lessons Learned

The design and delivery of the pilot offering was done by a team of two instructors from engineering disciplines. These instructors met for approximately six months before the start of the course to plan course logistics as well as learning objectives and activities through backward design. The instructors then delegated teaching and grading responsibilities based on alignment between content and areas of expertise. The instructors also worked together to coordinate guest speakers. If the course enrollment were to increase, it would be recommended that the size of the instructional team was to also grow to maintain similar workload responsibilities. Alternatively, an instructor could be given the position of course coordinator and be primarily responsible for organizing course content, managing grading, and securing guest speakers.

In addition to the logistics of course planning and management, the first iteration provided many other lessons learned. The course was designed to be multidisciplinary and welcome students from a variety of fields. While this was true of the pilot group of students, it also introduced a key challenge of developing and providing content that was both comprehensive enough to be useful to all students while specific enough to be helpful to individual students. In other words, it was difficult to provide practical applications and examples of various professional pathways for each student based on their unique backgrounds, experiences, interests, and goals. Informal discussions with students indicated that more explicit connections to their areas of interest would have been helpful and welcomed. While some assignments and reflections were intentionally broad and adaptable to distinct student interest, in future iterations the prompts could also be edited to help guide students to use online resources and the library system to identify additional, specific career pathways. Similarly, in-class content should be modified for future offerings

such as by inviting additional guest speakers who represent a wider variety of careers or developing class activities with varying instructions and examples so students can participate at the activity "station" that most closely relates to their field of study. For example, in the first delivery of the course, there was only one class dedicated to panel discussion. Exposure to more pathways could be facilitated by holding one or two additional panels.

For this first course iteration, 8 out of 15 students provided feedback on the formal, university-administered course evaluation system. One student commented: "I was able to gain a clear understanding of various aspects and strategically map out my career path." This was also demonstrated by the student maps created in the final Impact Portfolios. However, a student also noted that there were "too many objectives for one class period … always felt rushed." The breadth of content attempted in the first iteration was indeed more than could be covered during the 50-minute class sessions. For example, some of the warm-ups that were intended to be no more than 5-10 minutes in length would run over the allotted time if it sparked appropriate discussion amongst the students. Future iterations of the course would either need to edit the amount of activities and discussions during class periods or the course at large could be modified to be worth additional credit hours. This also impacted the number of cool down activities that were completed during class. Perhaps these cool down activities could be assigned as a brief (i.e., less than 10 minute) reflection to be completed in between class sessions.

Finally, future offerings of this course will formally collect and analyze individual student work to comprehensively evaluate the effectiveness of the activities, assessments, and program as a whole. This could include course-specific pre- and post-surveys or a qualitative content analysis of the responses in the Impact Portfolio or workbook.

6. Conclusion and Future Work

Similar to many other institutions, the offering university has a large undergraduate and graduate student population across dozens of disciplines, all of whom might benefit from understanding and reflecting on possible pathways of professional impact. While the pilot of this course intentionally limited the maximum enrollment, it is anticipated that the capacity increases and scales with subsequence offerings. This could either be done by increasing the capacity in a single section and having additional instructors and course assistants on the instructional team, or by keeping small class sizes across multiple sections. Both formats would be designed to maintain an active-learning classroom environment and ensure that students have individual interactions with instructors. The authors expect this course to remain an elective for students and not a requirement. However, the decision for how courses are counted towards degree, concentration, and certificate programs at the University of Illinois Urbana-Champaign is typically first considered by individual units and then reviewed and approved through various college and university channels. Future iterations of this course will continue to collect student feedback and formally assess student outcomes to adapt and refine the course material to best suit student needs

Undergraduate and graduate students are faced with a plethora of career options upon graduation, including in academia, industry, and through entrepreneurship. It is crucial to formally assist students in knowing what the multitude of options are as well as helping students understand their personal and professional values and how these might influence which career pathways

they might be interested in pursuing. It is also beneficial to provide students in STEM disciplines with formal content about the process of technology commercialization since this is done in a variety of professional contexts. A 1-credit hour course is one way that these learning goals could be taught and accomplished.

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