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Understanding the Values of, and Institutional Barriers Toward, Transforming Undergraduate Learning in the Pursuit of Innovation

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Introduction

Innovation education experiences have now become an expectation of the University to help prepare students with creative ways of thinking to address the issues they will face in their lives and careers. These innovation-focused experiences have seemingly become more important as universities are now touting their national rankings related to innovation output (i.e., patents, start-ups, etc.) while at the same time more people are questioning the value of higher education itself. As more people question the value of post-secondary programs, thinking about how innovation education contributes to students' personal and professional success is both vital and timely. That being said, it may be possible for universities to transform the ways in which teaching and learning occurs to provide an accessible pathway for every student to be innovative in their own way—furthering the value of higher education while engaging more undergraduates in the innovation ecosystem. By doing so, an exciting possibility is to culturally transform universities to prepare and professionalize students for pushing boundaries in new and bigger ways.

To date, many strategies have been implemented for innovation-focused learning, ranging from entrepreneurship programs to design-based coursework. But today, universities remain structurally challenged to implement adequate widespread evidence-based and transdisciplinary practices (Birx, 2019). More specifically, undergraduate learning continues to be siloed within individual colleges and departments. This situation can leave many students without vital, formalized transdisciplinary educational environments that are authentic to real societal challenges requiring innovation. Universities, however, can be the hub to provide the resources necessary for students to truly practice innovation in ways that are connected to their own passions. And, this learning experience can happen at a time in a student's life when they may have more freedom and flexibility to fail, iterate, learn, and potentially make an impact with their work that extends beyond the classroom. This type of approach to learning, however, requires a more critical investigation into current educational traditions and institutional structures to determine how teaching can span across disciplines and minimize the silo effect of academic departments/individual courses.

To address these concerns, a *National Science Foundation Improving Undergraduate STEM Education* project team is working toward developing a transformed, authentically transdisciplinary, and scalable educational model [referred to as the Mission, Meaning, Making (M3) model] for undergraduate learning focused on democratizing the practice of innovation. To achieve this task, the project team is testing and refining a model to guide the transformation of traditional undergraduate learning experiences to span academics silos. This educational model involves a) co-teaching and co-learning from faculty and students across different academic units/colleges as well as b) learning experiences spanning multiple semesters that immerse students in a community that can nourish both their learning and innovative ideas. As a collaborative initiative, this model is designed to synergize key strengths of an institution's engineering/technology, liberal arts, and business management colleges/units to create a transformative undergraduate experience focused on the pursuit of innovation—one that reaches

the broader campus community, regardless of students' backgrounds or majors. This objective is being achieved using a design-based research approach to co-design and implement the educational model with faculty across these three colleges/units while identifying and addressing the institutional barriers to a transformative learning experience. In addition, ethnographic methods are being employed to examine the university change process to a) identify best practices to guide this institutional transformation such as a) developing processes for scheduling/evaluating courses that are co-taught across colleges and b) scaling such programs to reach larger audiences and sustain learning over time. This paper highlights preliminary results of this project in regard to the undergraduate innovation model as well as the challenges and successes related to developing a cross-college program incorporating co-teaching and co-learning across engineering/technology, liberal arts, and business management.

Background & Methods

Holistically, this project seeks to address the question of "*how, and in what ways, can learning be transformed to span across disciplines to foster innovation-capabilities of diverse learners*?" Our central hypothesis is that a cross-college approach to educational transformation, one that centers on democratizing the practice of innovation across campus boundaries, will effectively prepare next generation innovators; and, that the current need for rapid/profound changes in higher education make conditions favorable for institutional transformation. Specific attention is focused on examining ways in which to work/teach across college boundaries. This examination is important as establishing transdisciplinary pedagogical approaches to collaboratively teach the practices of innovation across academic units, although it may sound like a simple idea, can be an extremely complicated process. Complications to cross-college collaborative teaching arise due to a variety of institutional barriers. To provide just one illustrative example, a thorny problem (*that should not be so*) is assigning credit to faculty in different colleges who are teaching courses in the same room at the same time. Accordingly, this research project is in the process of applying a design-based research (DBR) approach to develop an educational model to help guide the transformation of traditional undergraduate learning experiences to span academics silos.

A DBR approach was selected for this project as this methodology supports the blending of empirical educational research with theory-driven research to provide a deeper understanding of the phenomenon that is being studied (The Design-Based Research Collective, 2003; Gravemeijer & Cobb, 2006). As such, this method is providing the researchers a framework for iteratively testing and refining the educational model to address the identified institutional barriers and achieve close alignment to the anticipated student learning outcomes (i.e., integrative learning abilities, collaborative problem solving, innovation success, and teamwork capabilities in diverse teams). Through the DBR approach, the researchers are seeking to generate knowledge about how the resulting model can be broadly disseminated to the STEM education community and beyond. To inform the DBR approach, qualitative and quantitative data are being collected from faculty, students, staff, and administration throughout the implementation of the educational model to inform its revisions and document the institutional changes as well as workarounds necessary for its success.

The DBR plan began with the initial implementation of the model in 2021, whereas data were collected, analyzed, and used to redesign the model to be implemented in the next academic year.

This iterative process has included identifying and addressing barriers to success and understanding how the educational experiences can help students to make connections among ideas and actions to synthesize and transfer learning toward innovation achievement. Then, following the initial implementation of this model, a summer faculty DBR workshop was held to refine the educational approaches. During this DBR workshop, the participating faculty evaluated and improved course content to address the needs/values of the students, the pedagogical approaches necessary to deliver instruction across colleges, refine co-teaching methods and strategies, and develop learning community activities to support the innovative capabilities of students. This DBR workshop also involved identifying barriers to transformative teaching and strategizing ways in which to address/navigate these barriers. To complete these tasks, the DBR workshop involved a deep dive into the data collected during the first iteration of the model. These data included student surveys, interviews, and course artifacts as well as interviews with faculty, administration, and recent alumni of the program. The established semi-structured interview protocol included questions about motivation for innovation education, barriers to enrollment, how learning in the coursework extends beyond the classroom, the process and experience of co-teaching and co-learning across colleges, the essential elements of teaching innovation, and benefits/challenges related to the learning experience. In addition to the interview data, survey (post/retrospective) responses were collected from 54 students during the first iteration to determine their perspectives of the influence of the model on their abilities for 1) integrative learning, 2) teamwork, and 3) collaborative problem solving on a Likert-scale. These Likert-scale questions were based on the validated Association of American Colleges and Universities (AAC&U) VALUE rubrics (AAC&U, 2009a; 2009b; 2009c). The surveys also included open-ended questions related to their course experiences. The interview data and open-ended survey questions were transcribed and coded using a developed codebook while the Likert scale questions were analyzed using Wilcoxon Signed Ranks test to determine any significant changes in the student responses. All of these data were used in the DBR approach toward improving the educational model. These data allowed for understanding a) the value of this type of learning experience for students, b) what their learning desires are, and c) what should be the key aspects of innovation education. This information was used to then refine the course descriptions, objectives, activities, and catalog information to blend these disciplines together. This blending of disciplines was then positioned to offer an authentic learning experience that can help students practice innovation in their own contexts in ways that provide autonomy in learning, confidence in their abilities, and relatedness to other students across campus. The resulting iteration of the educational model was launched during the Fall 2021 semester and is under investigation currently. This model iteration included refined curriculum with faculty from all three colleges/disciplines co-teaching the courses to offer a transdisciplinary experience over multiple semesters. The barriers toward, and practices for, establishing these types of courses were documented to help others challenge traditional academic structures to offer cross-college programs.

Current Results

The preliminary results of this project will be presented in two sections. First, the current educational model resulting from the initial round of the DBR approach will be presented. Then, the preliminary results of the data analyses will be presented related to a) the value of this type of learning experience for students, b) what their learning desires are, c) the key aspects of innovation education, and d) the barriers/strategies for this type of approach.

A Current Cross-College Model for Innovation Education

Oftentimes, universities are structurally challenged to change which leaves even the strongest transformational ideas siloed within individual departments and schools (Brix, 2019). Consequently, this research project has begun to establish a model to guide the transformation of traditional undergraduate learning experiences to span across multiple disciplines, minimizing the silo effect of academic departments and individual courses. This model, which is referred to as the Mission Meaning Making (M3) project, has been designed to integrate the key strengths of three partnering academic units to provide an undergraduate innovation experience for the broader campus community. The philosophy of this model is that impactful innovation does not happen in silos. Instead, it requires a transdisciplinary approach to understand the meaning behind the problems people face, the mission for solving these problems to make positive contributions to people/communities, and making the solutions with the people they impact in mind (see Figure 1). This approach can then provide a community of campus resources to nourish student learning and the innovation culture/spirit.

Figure 1. M3 Program Philosophy for the Teaching of Innovation.

The M3 educational model has now been refined, through the DRB approach, to help enable undergraduates to become emergent innovators (see Figure 2). This model consists of three different components. First, there is a community with both people and resources that are committed to helping students achieve outcomes of innovation and learn the related practices through collaboration. The second component includes the college domains which allow for instructors in different departments to share areas of interest and key issues for co-teaching innovation-focused courses. Lastly, the curriculum of the model emphasizes shared practices and discourse for innovation through co-learning experiences. The educational model provides a unique collaboration between the partnering colleges with the goal to blend expertise that includes functional performance of engineering/technology/design, the human interface of liberal arts/social sciences, the economic perspectives of business management, and global/cultural appreciation to foster students' innovation-capabilities for a diverse world. As a result, the

educational experience is positioned to promote transdisciplinary learning and increase innovation experiences for the broader campus community.

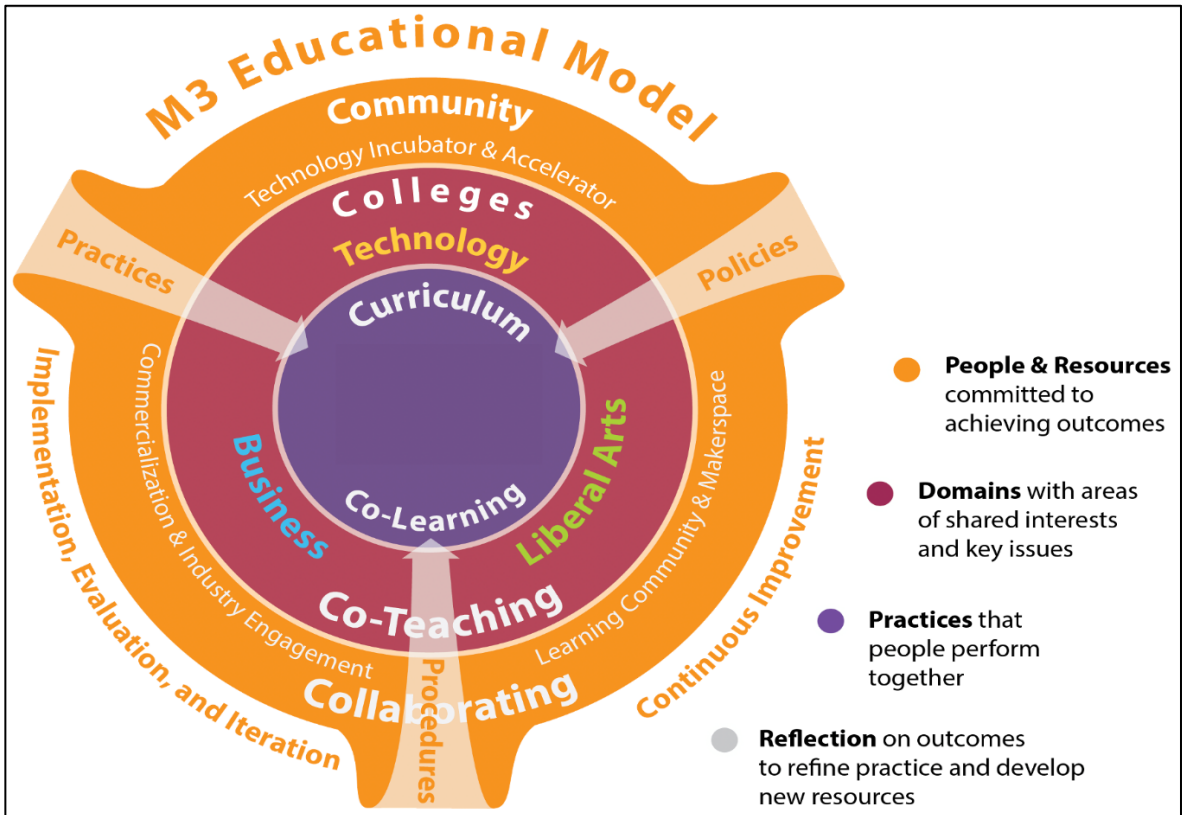

Figure 2. M3 Educational Model Overview.

At the center of the M3 model is the Design & Innovation (D&I) minor. The D&I minor was the starting point for piloting ideas for transforming undergraduate learning within a traditional curricular structure. This minor now establishes a common thread of design/innovation experiences throughout undergraduate programs along with multiple "entry points" to innovation for students based on their majors. The coursework is synchronized with several plans of study and therefore, becomes a new situated learning experience that does not require many additional credits for participation. The two core course elements of the D&I minor at the center of the M3 program have evolved to a) be co-taught with faculty across colleges and b) provide the space for students across all degree programs to interact with each other and begin to learn shared practices authentic to innovation. The first core course, *Designing Technology for People: Anthropological Approaches*, is co-taught with engineering technology faculty and anthropology faculty from the College of Liberal Arts. This course engages students in ethnographically studying human and technology interactions to support scoping problems and designing appropriate solutions for, and with, people. The second core course, *Prototyping for People: Thinking Strategically & Making Decisions*, is co-taught with engineering technology faculty and business management/entrepreneurship faculty. This course engages students in iteratively prototyping design solutions for the problems people face as well as prototyping potential business models related to these solutions. The students are led through the process of making strategic decisions related to their designs as they deepen their understanding of customer/user needs, market segments opportunities, costs of goods, competitor operations, and market

strategies. Importantly, this approach can help students realize the potential viability of their design solutions to impact people (Strimel, Kim, & Bosman, 2019). The M3 D&I learning sequence/plan of study can be found in Table 1.

Table 1. *M3 Design & Innovation Learning Sequence*

	Engineering Technology	**Liberal Arts**	**Business Management**	**Community of Practice Resources**
Disciplinary introductory Innovation Experience	Design Thinking in Technology	Technology & Culture	Making the Business Case	Coursework embeds connections to **Innovation & Technology Commercialization** resources to build a community of practice for all participating students: • Alumni Network • University Incubators & Accelerator • Office of Technology Commercialization • University Makerspaces • Student Co-working Spaces & Learning Community • Innovation Competitions • Careers Centers and Internship Programs
	Disciplinary-focused introductory innovation coursework leverages each college's expertise: builds the "on-ramp" to innovation.			
Core Design & Innovation Experience I	<u>Designing Technology for People: Anthropological Approaches</u> Co-Taught by Technology & Anthropology Faculty • Engages students in ethnographically studying human and technology interactions. • Helps students develop problem scoping skills in order to devise appropriate solutions for, and with, people. • Supports students in realizing that innovation opportunities emerge through observing and talking with people about how they interact with the world.			
Core Design & Innovation Experience II	<u>Prototyping for People: Thinking Strategically & Making Decisions</u> Co-Taught by Technology & Business Management/Entrepreneurship Faculty • Engages students in iteratively prototyping design solutions for problems people face and prototyping related business models. • Helps students develop entrepreneurial thinking while continually engaging with people to refine solutions. • Supports students in considering issues related to developing innovations that extend beyond technological feasibility to include customer desirability, social impacts, and business viability.			
Global/Cultural Experience	Provides students with opportunities to immerse themselves in diverse cultures to build more inclusive, diverse, and equitable perspectives critical for innovation successes that serve the whole of society.			
Specialization	Provides students with credit-bearing opportunities for expanding expertise related to their innovation areas through industry capstones, coursework, internships, or undergraduate research.			

In addition to the D&I minor, the M3 program seeks to build a community to nourish the innovation spirit of undergraduate students. Accordingly, an innovation-focused residential learning community was launched as part of the M3 model. This community has been designed to provide incoming undergraduate students with a campus network for both learning and technology commercialization. This learning community as well as the D&I minor also supports student innovation by providing an innovation competition at the end of each semester which affords students an opportunity to win cash prizes to help fund their innovative ideas as well as scholarships to continue pursuing the D&I minor. Lastly, the M3 model includes a pathway to innovation approach with a new structure to offering dual credit coursework to urban public high schools. This novel approach has been designed to enhance access to the program starting in high school. The new dual-credit approach, which is called the facilitator model, allows high school teachers to be trained in facilitating the innovation-focus curriculum in their schools day-to-day but with the university faculty being the instructor of record to evaluate the student progress. This strategy helps to navigate policies that inherently limit student access to early college learning while lowering the cost of tuition through dual credit. All these elements combined serve as the current iteration of

the M3 educational model. This model can serve as a blueprint for bringing academic units together to rethink innovation-focused education at the undergraduate level to move beyond the status quo and offer a transdisciplinary approach to learning that enhances the value of higher education for more students.

Through a preliminary analysis of student interviews, it was found that the participants in the M3 model felt a sense of freedom to explore project ideas, giving them confidence to move beyond the classroom and pursue personal and professional interests. For example, students are addressing important problems that matter to them in areas like social change, disability justice, etc. Notably, student teams from the pilot curriculum experienced success with their innovations that stemmed from effectively blending knowledge from the humanities, business development, and technology. To give examples, one student group received funding for their product to help those with movement impairments eat independently. A second group licensed their innovative kit for instructing elementary students about IoT (internet of things) technologies. Additionally, a third group devised a promising solution for pediatric needle phobia that focuses on the parent and child patient experiences and has worked with the university's technology commercialization resources to explore patent options. While the blending of disciplines has seemingly supported social innovation ideas and capabilities, there were also examples of monetary and entrepreneurial successes for undergraduates. Students within the program have already won over $250,000 in awards to further their innovative ideas generated through the curriculum, students have received external grants to support their start-up ventures, and others have sold their ideas or started their own online storefronts to sell their products. By having these transdisciplinary experiences, interview data also highlighted that student participants seem to be breaking down career silos, whereas they have used their innovation experiences to obtain careers outside of their disciplines/majors.

Outcomes/Barriers

A preliminary analysis of the stakeholder interviews revealed important findings related to the M3 project's overarching research question. These findings will be discussed in three primary themes, 1) student desires for learning and the value of the M3 approach, 2) the perceived essential aspects of innovation education, and 3) the institutional barriers and strategies toward teaching transformation.

Student Desires for learning and the Value of the M3 Approach. Findings indicated that when blending both technology and anthropology educational approaches, students as well as instructors became curious about each other's disciplines and work. Through the co-teaching model, instructors gained new knowledge and learned new skills from one another and were enabled to enact new methods of teaching with their students. Both students and instructors were exposed to new skills and practices resulting from the student work being performed throughout the courses. Students also seemed to benefit from having mixed teams, learning to value and rely on each other's skills and knowledge due to the diversity (i.e., different personal, professional and/or educational backgrounds) within groups. Some skills that were learned from these team projects were communication, organization, networking, and leveraging diversity of perspectives. These team projects also seemed to help create a sense of security (from a supportive network) for students which had them pushing the boundaries of their creativity, becoming more analytical, and having cross-disciplinary thinking.

In addition, students generally felt that they were provided the freedom to explore project ideas and given the confidence to pursue personal and professional interests that extend beyond coursework. The student/alumni also provided stories of how they used their innovation projects during job interviews to secure jobs, sometimes ones that were even outside of their disciplines/majors. While students did highlight the discomfort that comes with undertaking new challenges and a nonlinear process, there were many successes that were highlighted including instances of project teams confronting important social challenges in innovative ways as well as taking products they developed to market once the course had ended. Also, there were instances of failures for groups that pushed them to try innovative ideas and use new skills, allowing creative solutions to be developed and potentially putting them on the path to be innovators. Students noted that they learned to embrace failure, causing them to gain more critical-thinking and adaptive skills. More specifically, the student/alumni interviewees noted the following desires for an innovation-focused program: a) flexibility and freedom to take risks on ideas now as an undergraduate, b) developing a community/network for student support, c) having fun and engaging learning experiences, d) having opportunities to move ideas beyond courses, e) a better approach to student teams, f) having student backgrounds and experiences valued in the learning experience, g) access to university resources through coursework and not outside of class, h) obtaining that "something else" beyond their major, i) an opportunity to make a difference in the world, j) more hands-on experiences than typical courses, k) a better transition across coursework and a bridge to careers or "what's next" with novel ideas, and l) the support to take an idea from start to finish that could lead to something bigger than just obtaining a degree. Also, these learning experience desires seemed to align to the Self-Determination Theory of Motivation (Ryan & Deci, 2000). While this theory may not address the full spectrum of diversity across student learners, the identified desires or values for innovation-focus learning were coded into the three main overlapping constructs of this theory (see Figure 3) to potentially understand the overarching motivation for the transdisciplinary learning experience provided.

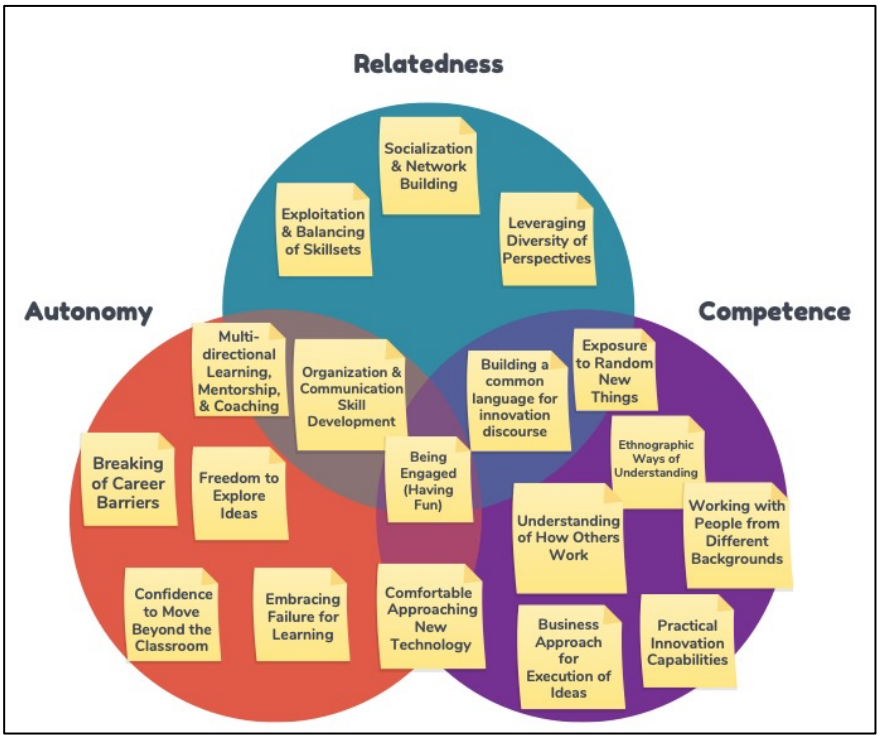

Figure 3. Identified Values for Student Learning in Alignment with Self-Determination Theory

Also, to better understand the value of this learning experience, post/retrospective student surveys were developed and implemented based on the AAC&U VALUE rubrics for the constructs of Integrative Learning, Problem Solving, and Teamwork. These surveys included Likert-scale prompts that were analyzed using a Wilcoxon Signed Ranked Test and 4 short answer questions about their learning experiences. The initial 54 student responses were analyzed related to these three constructs to determine any significant differences between the Post and Retrospective Pre-Surveys. For brevity of this preliminary analysis, there was a significant difference found across all three broad constructs at a p-value of ≤ 0.05. This difference in responses demonstrates an enhancement of the students' self-perceived abilities related to integrative learning, problem solving, and teamwork in a response to their M3 learning experience. The open-ended responses were analyzed for themes which included a) a change in excitement/perspective from start of the courses to end, b) an enhanced hope to better oneself by leveraging the course experiences, c) increased emphasis on the transdisciplinary relevance and expanded thinking through co-teaching and co-learning, d) an initial student anxiety toward using technology, and e) and increased realization of more possible career pathways. Example comments:

- "This course was a requirement for me; however, it ended up being one of my favorite classes."
- "This experience taught me to broaden my thinking and not be so constrained when thinking of a solution to a given problem."
- "This experience was important to me for my future career, where I will need to be empathetic of situations that can differ from my own."

The Key Aspects of Innovation Education. A preliminary analysis of the stakeholder interviews (i.e., students, alumni, faculty, and administrators) revealed the following key aspects, or practices, to learning within an innovation-focused program 1) identifying/designing problems, 2) involvement in collaborative problem solving (innovative teamwork), 3) developing business acumen or an entrepreneurial mindset, 4) devoting time for iteration and rapid prototyping/experimenting, 5) learning from failure and building resiliency, 6) addressing personal/group biases, 7) valuing/understanding the view points and work styles of others, 8) taking creative risks, 9) networking with the right people and connecting with available resources, 10) establishing opportunities for professional/personal growth, 11) engaging in ethnographic research, 12) becoming comfortable with sharing unfinished work, 13) embracing ambiguity, 14) promoting technology savviness, 15) developing a work ethic for getting things done, 16) designing for people through an empathetic approach, 17) applying different disciplinary lenses to problems or opportunities, and 18) being reflective and embracing criticism. These items could give insight toward establishing a set of shared practices for the teaching of innovation that could bridge across disciplines.

Institutional Barriers and Strategies. According to the stakeholder (i.e., faculty and administrators) interviews, creating a shift in the paradigm of undergraduate innovation education, or undergraduate learning more broadly, faces multiple barriers to both implementation and student participation. In general, the interviewees noted the following challenges for transdisciplinary or cross-college learning: a) different departmental norms (i.e., grading, course delivery, class size, etc.), b) program awareness and marketing that is easy for students and advisors to interpret across colleges, c) competing value structures across academic

units (the value of teaching vs. research vs. revenue generation), d) scheduling systems based on the traditional credit hour and faculty loading, e) duplication of efforts across the campus that spurs internal competition instead of complimentary practices, f) curriculum approval structures that are not in coordination across academic units, g) course naming and course ownership, h) traditional course structures such as lecture and laboratory settings and course time slots, i) a disconnect between those who approve curricular innovations and those that enter them into the university curriculum, scheduling, and degree auditing programs, j) university funding models that do not incentivize the creation/growth of non-major credentialling programs such as minor degrees, and k) that innovative programs do not seem to be recognizable to the university which places additional barriers to their implementation.

With different departments and colleges coming together, there then appears to be inherent conflicting academic norms such as class type and scheduling, advising of students, faculty/departmental value structures, and grading requirements. Consequently, the data indicate that developing programs across academic units is a challenge as faculty must work diligently to ensure department chairs, advisors, curriculum committees, and associate deans for undergraduate learning across all collaborating units are informed, and bought in, on the collaboration. Communication across these individuals is important as they are the ones responsible for scheduling faculty course loads, ensuring programs fit within the registrar systems, and that nuanced plans of study are sensible to students entering the program. Without this coordination, it is likely that teaching schedules will not operate properly across colleges and that advisors will be less inclined to promote student registration for the components of the program. In this research project, it also seems evident to the stakeholders that the automation of university systems seems to exacerbate these challenges. For example, automated systems for batch registration, advising, and course scheduling seem to push faculty and staff toward the "more traditional" means of educating students. It appears to the stakeholders that these automated systems are based on the traditions of higher education and therefore continue to pigeonhole teaching in the ways in which it has always been done. Therefore, without a coordinated effort across multiple university entities, from administration to advisors, the development of transdisciplinary programs is challenged to scale across the university and beyond. But, as found in this study, this coordination is difficult for faculty-initiated programs as there is often high turnover with administration and advising roles—causing a reboot in the communication every time someone leaves the university, changes roles, or retires.

Regarding the cross-college co-teaching approach specifically, it has been found to require elevated levels of communication and adaptability among both collaborating instructors and the participating students. For example, planning and scheduling courses across colleges with multiple instructors teaching at the same time is both a headache and time intensive process as this is not the tradition in higher education. Additionally, this is a challenge for participating students when they are planning schedules and meeting with advisors as courses offered with multiple instructors across different academic units again are not the norm in undergraduate programs. Also, the faculty seem to have the added responsibility of communicating and collaborating with a separate instructor, potentially causing unintentional duplication of efforts or dissent in opinions for the direction of the course. Managing busy schedules across faculty and ensuring clarity on course times, locations, and ownership can be a taxing process for instructors.

To date, the M3 model has highlighted some potential strategies for the cross-college co-teaching approach. The stakeholders found that multiple courses across academic units can be framed so that they "meet with" one another in the university system. Rather than cross listing a course, which can unfairly split instructor credit and imply academic ownership, this approach allows for different course listings for similar learning experiences (i.e., multiple course titles to be offered from the different colleges) to be reflective of student majors/academic homes and provide full credit to the instructors collaboratively teaching. For example, this approach can enable courses to be scheduled to "meet" at the same time in the same room within the university registration/scheduling systems, without the instructor credit being split in half, the learning objectives to be slightly different for different majors, and the advisors/students to have a more intuitive process for scheduling courses that are not typical of their programs of study. Then students can learn similar concepts with the hope that they also gain an understanding of how these skills can be applied to their personal areas of interest and possibly they can get interested in new things. However, finding faculty that are willing to collaborate and align with these approaches can be difficult. Rallying the community support needed for transdisciplinary programs, while trying to navigate how the program fits into the university along with populating the program with students is a major barrier. To encourage students to become innovators comfortable with pushing boundaries – or do not think in and are not limited in these siloed ways – it is essential to have systems that work in transdisciplinary ways.

While there are multiple barriers to the transformation of teaching and learning, the interviewees noted some key strategies to address the identified barriers. For example, they mentioned to 1) find the "pet projects" of the university (e.g., residential learning communities to promote student enrollment and engagement) to leverage their support/funding by championing their efforts, 2) understand university processes by taking on the "role of the student" to engage with these processes from their perspective, 3) to co-teach across colleges, have support for finding collaborative faculty/instructors, 4) be sure to engage with department chairs, information technology representatives, advisors, and associate deans when planning new programs and approaches, and lastly 5) establish a *Community of Transformation* to provide the resources and support to enact teaching/curricular innovation. As suggested by the stakeholders, the community of transformation strategy can be a possible overarching solution to these concerns. This approach could be developed into a university *educational innovation center/hub* for teaching and learning that would have a unique set of faculty/staff to assist with the development, organization, and scheduling of cross-college/transdisciplinary programs.

Discussion & Recommendations

The data collected through the M3 research project thus far have highlighted the potential value of cross-college, or transdisciplinary approaches to teaching, specifically regarding the practices of innovation with an emphasis on the understanding of problems and the people who face them. These values that are important for contemporary innovation education (i.e., providing the flexibility and freedom for students to take risks, building a student's network of resources and support, creating opportunities to move student ideas beyond coursework, etc.) and educational outcomes (i.e., learning to leverage a diversity of perspectives, understanding the proper exploitation and balancing of skillsets, enhancing student autonomy, developing practical innovation capabilities, cultivating a business approach for execution of ideas, etc.) can certainly

be viewed as important as humanity's most challenging problems and opportunities are not typically discipline specific. Instead, they likely require both a life-long commitment to learning and a more evenly balanced appreciation of how cognitive, technical, and social competencies/literacies can/do inform each other to lead to innovative thinking. However, as was found in this project, making headway for broader changes to undergraduate education in this transdisciplinary manner is challenging. This challenge was evidenced in the barriers identified related to scheduling courses across academic units, course ownership, faculty credit, and the academic traditions from individual units regarding curriculum approvals, course types (i.e., lectures vs labs vs blocks), and grading policies. This academic inflexibility of individual disciplines/colleges/departments has made adapting to new collaborative teaching philosophies difficult. While disciplinary expertise is necessary and vital feature of universities, the structures that come along with this can prevent modifications/improvements to the roles of academic units/disciplines that could better prepare students for the future of both work and learning. The balancing of disciplinary structure with transdisciplinary approaches to solving problems and learning is a challenge that must be continually addressed. With that being said, when promising ideas are developed, there are often also a lack of mechanisms in place to cultivate these ideas in order to grow them, nurture them, and scale them to be more accessible to students within and/or outside the university.

Accordingly, it seems necessary to move toward a more novel structure within higher education that enables faculty, staff, and students to more easily converge and iterate upon new and more valuable learning activities for all. The M3 project, even in its preliminary stages, provides much intriguing and multi-faceted evidence to show that this is the case. This is where the literature related to *Communities of Transformation* (CoT) literature can be leveraged to build a university ecosystem or hub to bridge across academic units to a) break the isolation of "islands of innovation" within individual units and b) enable the brainstorming of revised teaching practices to facilitate the adoption of new educational structures (Kezar & Gehrke, 2015; Shadle Liu, Lewis, & Minderhout, 2018). CoTs are similar to communities of practices, but involve philosophically exploring in depth the ways in which students are taught by introducing, and over time embodying, new practices that depart from those currently used within their institutions. This approach is believed to be one way to establish innovative spaces that do not currently exist with the potential to shift institutional and disciplinary norms. There are three main elements of CoTs which include 1) the formation and documentation of a compelling philosophy, 2) living integration of the philosophy throughout activities modeled by faculty (creating a new collection of practices), and 3) a community network to break the isolation of individual efforts, brainstorm revising practices, and help sustain changes once an individual returns to the status quo environment (Kezar & Gehrke, 2015). According to the research, benefits from enacting CoT approaches has led to greater improvement in teaching, leadership, and motivation to improve in these areas regardless of where faculty work, their position, or discipline and contributes greatly to overcoming typical barriers to change such as institutional reward structures or policies (Austin, 2011; Henderson, Beach, & Finkelstein, 2011; Kezar & Gehrke, 2015). As such, it seems that embracing the CoT idea may hold promise for institutions, including ours, to transform and help to move the conversations around new programs or teaching experimentation away from solely the "institutional resources" needed.

As a result, a recommendation is for institutions to develop a CoT through the creation of an educational innovation center that can encourage faculty, staff, and students to work across disciplinary departments and adopt a more transdisciplinary approach to learning. A CoT can then provide institutional support (including both funding as well as knowledge of institutional structures/policies) to test innovative ideas across academic units and scale the promising teaching results while potentially reducing the academic bureaucracy remaining from traditional educational structures/models. Accordingly, this approach should provide an agile and flexible structure to respond to new ideas and emerging challenges with more effective, evidence-based, and inclusive pedagogical practices which can hopefully improve outcomes for more students. For example, when creating new cross-disciplinary programs, rather than having curriculum committees to review from each individual department and college partnering on a transdisciplinary approach, there could be just one. Plus, this could be a home for such programs as it could eliminate the internal competition related to the ownership of courses, programs, credit hours, financial disputes about how resources are allocated to teach as well as provide increased access to the programs that may be outside of a student's academic home. Some could see this approach as being similar to the structures provided by units like honors colleges but at a broader scale. Lastly, by taking this approach, institutions could engage more instructors in the innovative teaching practices, help the practices expanding beyond the innovation's current disciplinary home, and provide institutional support to convening a coalition of instructors across diverse disciplines to create new programs or degrees for students (Shadle et al. 2018). However, as Hill (2020) mentions, limited research exists on the reforms of undergraduate education from an institution level, despite growing interests in approaches such as CoT to help address the challenges facing post-secondary learning. Therefore, a final recommendation is to continue investigating and documenting such approaches as higher education transformation efforts continue.

Conclusion

While various initiatives for providing innovation-focused learning have been tried, we must do more to culturally transform universities to prepare and professionalize students for pushing boundaries in new and bigger ways. To best meet society's urgent needs, undergraduates must learn to embrace and build on new ideas, processes, and ways of seeing things that represent a departure from the norm and add value to the world in a manner that emphasize personal and social responsibility across fields of study. Thus, developing a new, scalable model for undergraduate education that democratizes the practice of innovation across campuses, regardless of a student's background or major, and generates a creative, robust workforce is vital. And, colleges and universities now have the opportunity, and responsibility, to build a better educational system in novel and much needed ways. Recent pandemic times have only highlighted why this is such an important goal and one that all educators must focus on addressing. However, there are several barriers to more transdisciplinary ways of teaching resulting from the educational silos of academic disciplines and higher education traditions. These barriers require institutional support to establish guidance for navigating these traditions and changing the traditions that may be outdated. Based on the preliminary results from the M3 project, the educational model seems valuable for helping others develop innovation-focused undergraduate programs spanning across academic units and that the CoT approach seems promising to support these types of educational transformation efforts at the institutional level. It is the researchers'

hopes that these approaches and the information from this ongoing research can be beneficial for universities seeking to scale transdisciplinary programs and ultimately help enhance the value of higher education for students and society.

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