2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #39562

Board 342: Moving Toward Transdisciplinary Learning Around Topics of Convergence: Is it really Possible in Higher Education Today?

Dr. Greg J. Strimel, Purdue University, West Lafayette

Greg J. Strimel, Ph.D., is an associate professor of Technology Leadership and Innovation and program lead for the Design and Innovation Minor at Purdue University. Dr. Strimel conducts research on design pedagogy, cognition, and assessment as well as P-12 engineering/technology teaching and learning.

Douglas Edward Pruim
Deana Lucas
Dr. Todd Kelley, Purdue University, West Lafayette

Todd R. Kelley is an Associate Professor in Technology Leadership and Innovation. Dr. Kelley joined Purdue in 2008 upon completion of his PhD at the University of Georgia. He was hired as a P-12 STEM educational researcher and technology teacher educator.

Jung Joo Sohn, Purdue University, West Lafayette

Moving Toward Transdisciplinary Learning Around Topics of Convergence: *Is it really Possible in Higher Education Today?*

Introduction

There have been numerous demands for enhancements in the way undergraduate learning occurs today, especially at a time when the value of higher education continues to be called into question (The Boyer 2030 Commission, 2022). One type of demand has been for the increased integration of subjects/disciplines around relevant issues/topics—with a more recent trend of seeking transdisciplinary learning experiences for students (Sheets, 2016; American Association for the Advancement of Science, 2019). Transdisciplinary learning can be viewed as the holistic way of working equally across disciplines to transcend their own disciplinary boundaries to form new conceptual understandings as well as develop new ways in which to address complex topics or challenges (Ertas, Maxwell, Rainey, & Tanik, 2003; Park & Son, 2010). This transdisciplinary approach can be important as humanity's problems are not typically discipline specific and require the convergence of competencies to lead to innovative thinking across fields of study. However, higher education continues to be siloed which makes the authentic teaching of converging topics, such as innovation, human-technology interactions, climate concerns, or harnessing the data revolution, organizationally difficult (Birx, 2019; Serdyukov, 2017). For example, working across a university's academic units to collaboratively teach, or co-teach, around topics of convergence are likely to be rejected by the university systems that have been built upon longstanding traditions. While disciplinary expertise is necessary and one of higher education's strengths, the structures and academic rigidity that come along with the disciplinary silos 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 persistently addressed. These institutional challenges will only continue to limit universities seeking toward scaling transdisciplinary programs and experimenting with novel ways to enhance the value of higher education for students and society. This then restricts innovations to teaching and also hinders the sharing of important practices across disciplines.

To address these concerns, a *National Science Foundation* Improving Undergraduate STEM Education project team, which is the topic of this paper, has set the goal of developing/implementing/testing an authentically transdisciplinary, and scalable educational model in an effort to help guide the transformation of traditional undergraduate learning to span academics silos. This educational model, referred to as the Mission, Meaning, Making (M3) program, is specifically focused on teaching the cross-cutting practices of innovation by a) implementing co-teaching and co-learning from faculty and students across different academic units/colleges as well as b) offering learning experiences spanning multiple semesters that immerse students in a community that can nourish both their learning and innovative ideas. As a collaborative initiative, the M3 program is designed to synergize key strengths of an institution's engineering/technology, liberal arts, and business 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. Throughout the development of this model, research was conducted to help identify institutional barriers toward creating such a cross-college program at a research-intensive public university along with uncovering ways in which to address these barriers. While data can show how students value and enjoy transdisciplinary experiences, universities are not likely to be structured in a way to support these educational initiatives and they will face challenges throughout their lifespan. These challenges can result from administration turnover whereas mutual agreements across colleges may then vanish, continued disputes over academic territory, and challenges over resource allotments. Essentially, there may be little to no incentives for academic departments to engage in transdisciplinary programming within the existing structures of higher education. However, some insights and practices have emerged from this research project that can be useful in moving toward

transdisciplinary learning around topics of convergence. Accordingly, the paper will highlight features of an educational model that spans disciplines along with the workarounds to current institutional barriers. This paper will also provide lessons learned related to 1) the potential pitfalls with educational programming becoming "un-disciplinary" rather than transdisciplinary, 2) ways in which to incentivize departments/faculty to engage in transdisciplinary efforts, and 3) new structures within higher education that can be used to help faculty/students/staff to more easily converge to increase access to learning across academic boundaries.

Design-Based Research Approach

To develop an authentically transdisciplinary educational model in an effort to help guide the transformation of undergraduate learning to span academics silos, a design-based research approach was used. This approach consisted of faculty from three academic colleges (i.e., engineering/technology, liberal arts, and business management) working collaboratively to design, test, and iterate a transdisciplinary undergraduate program based on the continuous collection of data from a variety of sources. These sources included interviews from a mixture of stakeholders (instructors, administrators, students, alumni, and advisors), pre-post-retrospective surveys from students within the program, student work, and reflections from an embedded ethnographer. The analyzed data includes interviews from 30 students, 20 alumni, and 14 faculty/administrators/advisors as well as over 241 pre/post/retrospective survey responses. The data from these sources were analyzed and reviewed by the cross-college faculty for refinements to the model at the end of each academic year as well as for identifying institutional barriers toward, and strategies for, transdisciplinary programming. As a result, a model has been developed that is specifically focused on immersing students in the cross-cutting practices of design and innovation through a) co-teaching and co-learning from faculty and students across different academic colleges as well as b) offering learning experiences that traverse multiple semesters within a community that can nourish both their learning and innovative ideas.

While the teaching of design and innovation is not novel in of itself, providing a way in which to teach collaboratively across colleges/units within large universities can be of benefit when reaching toward more transformative, innovative, and/or potentially more valuable learning experiences for students. As mentioned earlier, the increasingly complex challenges that face society will likely require new ways of thinking that can emerge by applying different disciplinary lens/viewpoints to problems. But, the disciplinary structures in higher education, while not all bad, do not readily provide a place for students and faculty within these disciplines to converge. For example, assigning multiple instructors from different colleges to teach in the same room at the same time do not coincide with university systems/structures/values. Also, gaining curriculum approvals within a larger institution across academic units, each with their own curriculum oversight committees, is a difficult and time-consuming process. That said, the following sections will provide an overview of this model and lessons learned from its implementation through the design-based research approach.

A Model to Address Institutional Barriers to Transdisciplinary Learning

The M3 program focuses on providing any and all students with an opportunity to truly practice innovation in ways that are connected to the needs of people. In addition, the program provides the curricular space and time for students to work on their ideas while connecting them with the strengths/resources of a large research institution. A believed value of this program is that it occurs at a point in many students lives when they have freedom and flexibility to fail, iterate, learn, and potentially make an impact with their ideas in ways that extend beyond the classroom. This opportunity to make an impact on society as well as their own lives, can be seen as a way to enhance the value of the higher education experience. The core features of the M3 program are 1) the cross-college co-teaching of courses that build into a minor degree open to all students, 2) a residential learning community to leverage the

strength of an R1 institution to nourish student innovative ideas and learning experiences through the convergence of disciplinary knowledge, and 3) a novel early college pathway for students to enter the program while still in high school.

Cross-College Collaborative Teaching Approach. The cross-college co-teaching approach is believed to be the most unique/breakthrough aspect of the M3 program to support transdisciplinary learning. The university systems/structures/values are not established in a way to easily allow faculty from different academic colleges/units to teach courses together at the same time to students across all majors. However, a strategy that was developed through this process is creating a course from each academic home that then "meet with each other." For example, at the center of the curriculum are two collaboratively taught courses. First, is a course titled *Designing Technology for People: Anthropological Approaches*. This course involves technology and anthropology faculty teaching in the same room at the same time, focusing on ethnographic approaches to study people and identifying opportunities for designing innovative solutions to the problems they face. This course has multiple titles, one from technology and one from anthropology. These courses are then scheduled to "meet together" in the university registrar system—enabling the two faculty to receive full credit for teaching collaboratively. The students then fill seats across both sections of the course, again allowing the instructors to share full credit. Another collaboratively taught course is titled *Prototyping Technology for People: Making Decisions and Thinking Strategically*. This course involves technology and business faculty teaching the integration of prototyping and business development to bring the student designs/ideas/solutions developed in the previous course to fruition. Again, this course has two course titles/numbers, one from technology and one from business, that "meet together" while faculty maintain full credit for teaching a course. Then, to enable students to converge within these collaborative taught courses, a series of early-level courses from each unit were connected to create disciplinary-focused entry points into the program. These entry courses can allow students to build their disciplinary viewpoints and skills first and then begin to explore how they can be valuable to apply. Also, the disciplinary entry points enabled students to begin building their disciplinary knowledge and then converge with others in the collaboratively taught courses to work on an innovation project over multiple semesters with applying different disciplinary lenses to potentially arrive at new and unconventional solutions.

The entry courses along with the collaborative courses build a learning sequence that leads to a minor degree in design and innovation. While minor degrees are not novel, it was found that the programming had to be linked to something of recognizable/tangible value to students. Through student and advisor interviews, it was found that advising programs are automated to direct students toward "checking boxes" for a plan of study without consideration of the nuances of different types of learning opportunities. The main goal of pursuing higher education for students is to essentially receive credentials that have value for future careers. So, it is important to understand the degree planning systems and use them to enable students to get more out of their time at the university and achieve this goal. Thus, the M3 program, while at its core has an "add-on" minor, the program leverages the knowledge of the university systems to provide a space for disciplines to converge. M3 then provides a common thread of innovation to students throughout their undergraduate program with multiple "entry points" to innovation based on their major. The coursework is then synchronized with plans of study and therefore, becomes a new situated learning experience that does not require a large number of additional credits for participation. Oftentimes these courses fill core requirements for their major, not adding time to degree completion. Then the program provides the space for students from across degree programs to interact with each other and engage in the shared practices of innovation within a diverse group of learners and mentors to nurture their innovation spirit and set up for lifelong learning. Figure 1 provides a graphic representation of how the minor degree plan of study is situated to enable the disciplines to converge.

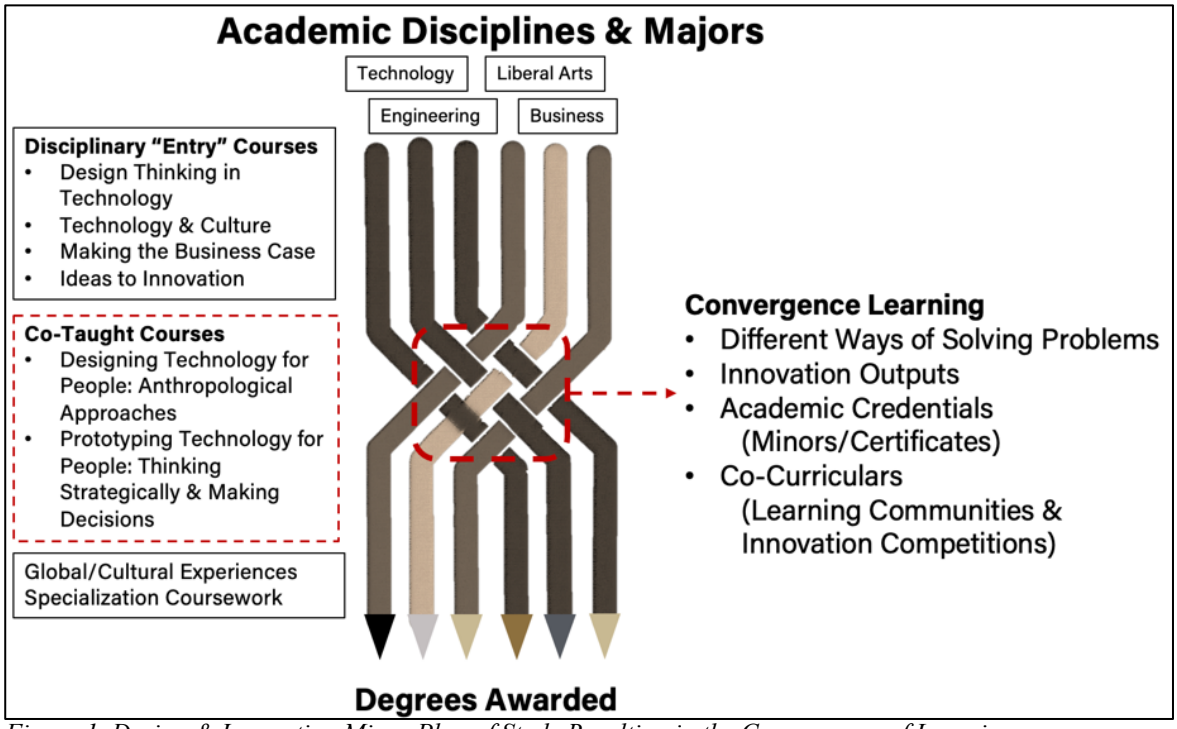

Figure 1. Design & Innovation Minor Plan of Study Resulting in the Convergence of Learning.

However, the problem still remains that an academic home is likely necessary for a such a program to exist in the traditional higher education structure. An academic home for a program/minor degree then implies ownership of the program by a discipline which can continue to spark debates over academic territory. In addition, creating a cross-college program then faces the difficult and time-consuming process of gaining curriculum approvals across academic units that are not in sync. That being said, the M3 program experienced enrollment growth within the collaborative-taught courses as well as within the transdisciplinary minor since the start of the research project. For example, 336 students have completed the collaboratively taught course between technology and anthropology in the last 2 years and 247 students officially declared the design and innovation minor over the past 3 years. Through the 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 related to social change. Also, student teams have experienced successes with their innovations that stemmed from effectively blending knowledge from the humanities, business development, and engineering technology. To give examples, two student groups received external funding for their products to help those with movement impairments and arthritis. A second group licensed their innovative kit for instructing elementary students about computational thinking through building model "Smart" clubhouses. 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 possibilities with their idea. 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 now won over $285,000 in awards to further their innovative ideas generated through the coursework, 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.

Residential Learning Community: Leveraging University Investments. Another core feature of the M3 program is a residential learning community. The goal of the learning community is to connect students with the resources of a large research institution to nourish their innovations/ideas. Also, the hope is to then provide students with a clear pathway into the minor degree program. The learning community has been found to be another strategy for developing a place for disciplines to converge. As the learning community structure exists outside of academic colleges, faculty and students are enabled to work together outside of their disciplines. Plus, the university invests in an infrastructure to support residential learning communities. In fact, the university provides funds per student enrolled that can be used to support learning experiences for the students. By strategically leveraging this infrastructure and university investment, the M3 program was able to easily build out a community and network to nourish student-driven innovation that is supported by the collaboration of faculty from different academic disciplines. For example, the learning community has allowed students to live, work, and collaborate together outside of normal class time with a minimal investment of resources from the three participating colleges. Therefore, a key strategy for developing a place for disciplines to converge can be to find and leverage university investments into specific initiatives such as residential learning communities.

An Early College Pathway: Addressing Restrictions to Innovation. The third core feature of the M3 model is a novel early college pathway for students to enter the program while still in high school. The strategy with this approach was to engage students early to foster innovative thinking and introduce them to the opportunities that the university can provide them to grow and develop their own ideas. In addition, a major goal was to engage with urban schools to help increase access to early college opportunities to more students. However, as found within this project, academic policies and traditions can restrict access to such opportunities. For example, a tradition is that research intensive universities typically do not engage in dual credit programming with high schools for reasons such as maintaining the fidelity of implementation related to coursework, limited short-term financial incentives, and accreditation concerns—all of which can be valid reasons. In addition, higher education policies can restrict access to such opportunities, especially to high schools with limited resources, as there are requirements for the high school teachers involved to have a Master's degree within the specific discipline. But, with the M3 program, a different approach has been established to offer one of the "entry courses" to the minor degree within high schools during the typical school day. This approach, referred to as the facilitator model, has a university instructor serve as the "instructor of record" for the course that is implemented across several high schools during the school day (Thorne, Strimel, Mentzer, & Sears, 2022). The "instructor of record" then trains and works with the high school teachers to facilitate the day-to-day lessons within the school. The participating students then submit all assignments through the university's learning management system whereas the "instructor of record", along with support of graders hired to assess student work for the course on campus, evaluate all student work. This approach ensures the fidelity of implementation of the curriculum by the high school teachers, 2) allows for students to earn direct college credit for the coursework, and 3) reduces the requirements needed for schools to implement early college experiences, such as teachers having a master's degree in the subject area (which is a specific barrier in STEM areas such as engineering and technology as there are limited opportunities for teachers to earn master's degrees in these subjects). It is the hope that this approach can help to broaden participation in the M3 program and then further democratize the practices of innovation.

Lessons Learned from Implementation

To Be Transdisciplinary or Not to Be. Yes, it can be said that transdisciplinary problems in our world require transdisciplinary solutions. And, if this is the case, then higher education should provide transdisciplinary learning experiences to all students. However, as experienced through this research project, transdisciplinary learning is not widely understood and easily recognizable by students, instructors, administrators, advisors, and systems for registration, scheduling, and advising. Therefore, it

is important to understand and clearly communicate the meaning, purpose, and place for transdisciplinary learning. Through this research project, it has been found that there are a variety of interpretations of transdisciplinary learning and general confusion with interdisciplinary and multidisciplinary programming. For example, when the university sets goals to create transdisciplinary programs, views on this programming can range from *developing a major within one academic college that blends together courses from their various majors* to *generating a degree plan that includes select courses from different colleges to form a "transdisciplinary" major*. While these programs can be valuable, neither provide an authentically transdisciplinary learning experience for students and do not offer opportunities for students and faculty across disciplines to easily converge. To become transdisciplinary, collaboratively teaching around topics that exist outside of a single discipline whereas each discipline is valued equally appears to be the necessary approach. The goal of this approach can then be to offer unconventional/innovative ways to explore these topics through the convergence of disciplines rather than an approach of merely "having an engineering student take an anthropology course."

While cross-college and/or collaboratively taught programs can provide a valuable experience, we also found that too much of a good thing can be bad. Disciplines should exist and not everything should be transdisciplinary. As was found, for transdisciplinary learning to work, students need something (skills/knowledge/perspectives) to bring with them to the learning experience. If students exist solely in a transdisciplinary space, then when working with others, they may not feel of value in the collaborative work. The students interviewed often expressed their appreciation toward having a "space" to apply what they are learning in their disciplines while collaborating with others of different skillsets. If students did not have their disciplinary background/interests to apply, then benefits of transdisciplinary learning would likely not be achieved and students may not feel of value to the experience. An example of this idea was found at the institution through the creation of a *transdisciplinary studies* undergraduate major in one academic college. This program allowed students to tailor their own academic pathways with large blocks of time for portfolio development, advising, and personally selected projects. However, an issue with this program was that students felt as if they had no academic home and that they could not clearly communicate their value as their degree was not easily recognizable to students, advisors, academic systems, and future employers. So rather than being transdisciplinary, one could view this major as being more "un-disciplinary." This program has been discontinued and reinforced the idea that disciplines are important within academic institutions and that silos need not to be completely dismantled.

The question then is "what should exist as transdisciplinary education?" Our work has led us to focus transdisciplinary learning on problems or topic areas that exist outside of disciplines and require a convergence of knowledge, skills, and perspectives to address. Essentially, providing topics of convergence where disciplines, students, and faculty can intersect and an additional learning experience, tied to novel academic credentials, can exist. Figure 2 provides a graphic of how this idea of convergence learning can exist, along with disciplinary and convergence research of an institution. As students

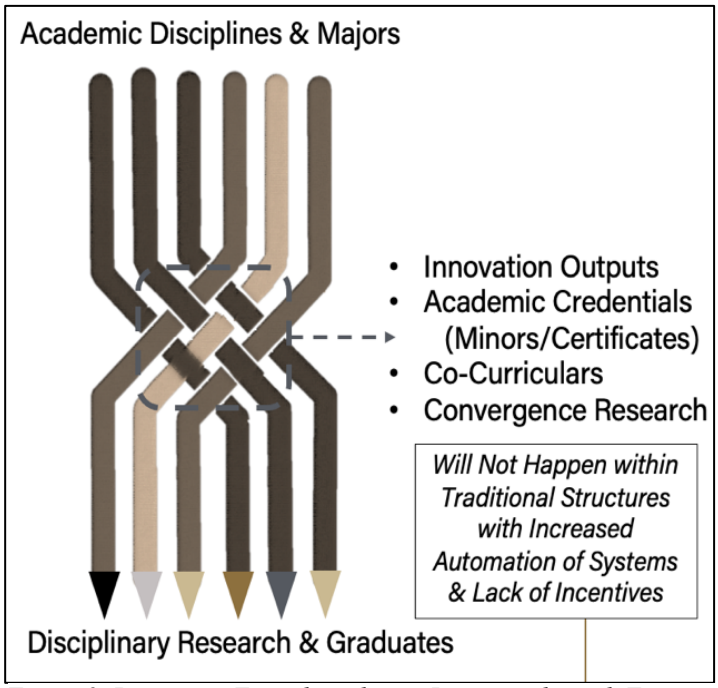

Figure 2. Promoting Transdisciplinary Learning through Topics of Convergence while Preserving Academic Disciplines.

enter academic institutions, they typically enter in a major within a disciplinary home which eventually results in them graduating with a degree. Within these disciplinary homes, faculty also refine expertise and generate new knowledge within their disciplines. But, if there are strategic opportunities for these disciplines to converge to provide transdisciplinary learning experiences for students, the university can promote additional academic outputs such as innovations spurred by the co-mingling of disciplinary lenses to new problems/opportunities from both students and faculty, unique academic credentials that have recognizable value to students such as minors, certificates, or badges, increased use of university resources and application of student knowledge/interests through co-curriculars that can make an impact beyond the classroom, and promoting new opportunities for convergence research. But the students and faculty still maintain a disciplinary home in which to graduate with a degree and to continue to push expertise in a discipline. However, it is likely that convergent learning spaces/programs will fail to launch within traditional higher education structures where there is a lack of incentives for working outside disciplines and as academic systems have become increasingly automated to assist in scheduling courses and registering students in the manner that they have always been done.

There is Value for Learning, But No Incentives. Through this design-based research project, the data do continue to highlight the value of transdisciplinary learning experiences for students. For example, data collected during the implementation of the model were analyzed to a) identify student perceptions of the co-teaching and co-learning pedagogical approach as well as b) determine the influence of this model on student innovation skills (i.e., integrative learning, teamwork, and problem solving). The results of this analysis revealed students felt that 1) the cross-college collaboration enhanced their brainstorming and ideation abilities, 2) the transdisciplinary setting for learning allowed for them to apply their prior knowledge, and 3) multiple instructors allowed for them to receive a greater range of feedback throughout their innovation projects. In addition, the results indicated that there was a statistically significant difference in the students' perceptions of their innovation capabilities related to the constructs of both integrative learning and problem solving. However, students' perceptions of their abilities relating to teamwork seemed to change to a more realistic perception after the program. The data show that the students perceived themselves as being better at teamwork before the co-taught courses than afterwards. But when asked to be retrospective, the students do not think they were as good as they originally perceived—suggesting that working across disciplines was more challenging than initially thought. That being said, the student did find that working in teams was valuable for building the skillset needed in their future work. We also have investigated how the M3 co-teaching and co-learning may influence the way in which students frame design problems (Otto & Strimel, 2021). The results suggest that student participants shift their focus on design problem framing activities from the technical aspects of a problem to more customer and business-oriented perspectives after completing the collaboratively taught coursework. This can be important as it is deemed necessary for innovators to consider various issues such as customer desirability, social impact, and business viability, not just those related to technical feasibility to achieve more appropriate solutions to problems. In addition to these findings, we found that values that students/alum/administration/faculty discuss in relation to the program are a) the benefits of meeting a wide range of people, b) the strengths of learning together with people that have different knowledge, skills, and talents, c) learning to interact with those who approach problem solving differently, and d) understanding how to merge communication and working styles of diverse group members. We also found that when co-teaching instructors are in synch that students receive quality communication from instructors, receive valuable feedback, are encouraged to push boundaries, and receive a truly student-centered learning experience.

While these results can highlight the value of transdisciplinary opportunities in regard to student learning, the incentives for academic departments/colleges as well as individual faculty to participate in such programming are essentially non-existent. In fact, through the project, we have found disincentives to engage in this type of work—effectively preventing any educational innovations before they are ever tried. To elaborate, financial models for universities are typically established from an individual unit

perspective. For example, funding for departments is often based on the enrollment of students in specific majors. This perspective drives internal competition between academic departments and does not readily allow for programming to exist outside of an academic home. So, if a new academic credential is developed for students, such as a minor degree, based on a newer pedagogical approach or transdisciplinary topic, there are no additional financial incentives for the department—even if enrollment in the new program grows and student learning is enhanced. Then, why should a department provide resources for such a program? In addition, why would faculty want to engage in the creation and implementation of transdisciplinary programming and collaborative teaching? As found through this project, this work takes more time than it does for teaching a regular course. Faculty need to coordinate the scheduling of classes across colleges, which does not easily align as each has their own traditions to contend with, and are then found within disputes over academic territories of the disciplines. And, within research-intensive universities, this faculty challenge is situated in an academic environment where teaching and learning efforts are not as valued within promotion and/or tenure reviews as other efforts.

Accordingly, it could be time to rethink institutional funding models and critically review institutional investments in learning. There are examples where departmental funding is partially based upon student credit hours rather than solely the number of those enrolled in a major. This approach can potentially incentivize departments to provide learning experiences that draw more students from different backgrounds/majors to their unique courses/programs—spurring more educational innovation to occur.

Considering Belongingness is Critical. Just because you want students from different backgrounds to converge around a topic, problem, or opportunity, does not mean they will feel that they belong in a certain space. Through our data analysis we continue to see that students value the development of friendships with people they normally would not have class with, students feel that transdisciplinary learning is actually fun, students appreciate that they get to share their individual talents/strengths with other students, and students appreciate the usefulness of the extended network that they develop across disciplines. However, there are still gaps in knowledge around who may feel like they belong in this space and how broader and more diverse audiences can be connected. As a goal for this transdisciplinary learning was to engage the broader campus community to bring disciplines and perspectives together, an additional investigation was conducted with the survey data to explore how student participation in this collaborative model and their perceptions of their innovation skills may vary regarding major and gender. This exploration can be important as 1) the model may or may not be meeting the needs of participants across areas of study and 2) perceptions of abilities may influence a sense of belongingness for people within the model's programming. A two-way mixed analysis of variance 119 students survey responses revealed a significant main effect of coursework on the constructs of integrative learning, teamwork, and problem-solving skills for participating students, however no interaction effects were found on gender or college major. These results are certainly promising and may reveal ways in which transdisciplinary learning can bring more people into topics that they may have initially perceived as not fitting for them. However, through interactions with students, it can often be heard that innovation is not for them because of their major. So, it is important to consider how the different disciplines consider their belongingness within a program or the convergence of disciplines will not naturally occur.

Items to Consider When Getting Started – Institutional Structure Needed. When it is desired to develop a transdisciplinary program, we have identified a list of items to consider. First, one should consider who is the initiator of the transdisciplinary program. Is the program development driven by department heads, deans, faculty, and/or students? Then, it is important to really consider the need for either a transdisciplinary, interdisciplinary, cross-college and/or collaboratively taught program. The creation and launch of such programs will likely need top-down support as well as resources to subsidize the "start-up" of the program. If the need transdisciplinary programming is valid, then a clear goal for the program should be established in order to benchmark what already exists at the university related to this goal. This benchmarking is important before beginning the creation of the program as there often duplication of

efforts at large universities. This benchmarking can also help to identify where disputes over "academic territories" may occur. So, one should answer whether or not a form of the desired program already exists and if there are others working on a similar approach to learning. The answer to these questions will help determine whether a new program needs to be created or if rearranging/redesigning something that already exists is the appropriate approach to filling the desired educational need. Next, it will be valuable to assess the current educational landscape at the institution, considering factors such as the institutional history and identity, leadership involved, organizational structure, teaching and learning supports, cocurriculars, faculty rewards, financial models (minors and courses do not likely bring funds to the department), and the current undergraduate student trends. One strategy, which seems to be overlooked, is asking academic advisors for their feedback on the idea before initiating the program. The advisor viewpoint can be important to determine how the program will be of recognized value to students. As we have learned, students do not just come to a program for the learning value alone. They still seek to "check the box" to acquire academic credentials for specific career paths. While there are innovative approaches to providing educational outcomes, the current recognized value for participating in an academic program is a major, minor, or certificate that can clearly communicate an additional attribute that the student can bring with them to a future employer.

Assuming that through all of these considerations a framework for a transdisciplinary program is established, then the following questions would likely be valuable to consider:

- What is the agreement between participating colleges/units (think about how credit, resources, revenue, costs, courses, faculty, and students are shared)?
- How will the program become known (who will market the program and recruit students)?
- How will students from a variety of backgrounds and interests feel that they belong within the program?

Lastly, once a program plan is established, then it will be important to consider how the program's curriculum will progress through the barriers associated with academic traditions in the current landscape of the institution. We have identified the following barriers to transdisciplinary learning and collaborative teaching across academic units:

- **Administration Issues**
    - ***The Resource Question:*** Co-teaching is costly with multiple faculty for one class. How do we "sell" the value of the transdisciplinary approach for the class in light of this question?
    - ***The Low Number Problem:*** New ventures and experiments often take time to grow and develop. These classes are vulnerable to cancellation. This can happen repeatedly in early days.
    - ***The Bureaucracy Problem:*** Changes require a series of approvals. This takes time, and any step could shut down the process (and not everyone may know the vision or intention).
    - ***The Assistant Funding Question:*** Who pays for graduate or teaching assistant? If the cost is shared, are the rates the same? Are the payment processes coordinated?
- **System Issues**
    - ***Database Issues:*** The system is not designed to recognize two faculty in one room/class at the same time.
    - ***Batch scheduling:*** Batch scheduling systems can deter student enrollment in a program if classes are deprioritized for any unforeseen reason.
    - ***Room Scheduling:*** Specific room needs (e.g., active learning spaces) are sometimes difficult to find on campus.
    - ***Student Evaluations:*** It is important to ensure that both/all faculty involved receive course evaluations.
- **Staff/support issues**

    - ***Advising***: We have experienced advisors "turning off the faucet" for enrollment because they did not understand how course fit within and across plans of study.
    - ***Churn***: People come and go, and institutional knowledge is lost due to churn and attrition. Promises, agreements, and conversations establishing something can be lost as people move on.
    - ***Communication***: How do we make sure plans are communicated across departments and to all key partners?
- **University Issues**
    - ***Lack of coordination***: We have witnessed transdisciplinary efforts, spaces, and personnel be duplicated across campus; the parties involved were not aware of the others doing something similar or working toward the same goals with different elements of support.
- **Teaching Issues**
    - Establishing balanced teaching and expectations between and among teachers.
    - Clear communication between instructors to ensure they are in sync with expectations when working with students.

As one can see, the development of transdisciplinary programming and collaborative teaching across colleges is a convoluted, complicated, and time-consuming process that individual faculty will not likely engage with. Therefore, it is more likely that new structures within higher education are needed if this type of learning is desired. A novel structure can serve as a support system for educational innovations that exist alongside the academic disciplines. This structure could be a strategic investment for the university that could serve as a community of transformation that streamlines the development of cross-college programming. Not only could such an educational innovation-focused unit help reduce the duplication of efforts across campuses but could also coordinate approval processes for, and scheduling of, learning experiences that exists outside of academic homes. Then by streamlining processes, resources can be used more efficiently to engage faculty/students/staff in convergence of disciplines and increase access to learning across academic boundaries.

Conclusion

Transdisciplinary learning seems to hold potential for enhancing the value of higher education by offering a more integrated, hands-on, and innovative approach to learning. This approach can enable students to more readily impact their lives as well as the lives of others. For example, by providing the space for disciplines to converge through teaching, as well as research, students and faculty can explore new and unconventional ideas that they might not have considered otherwise—leading to potential for new discoveries, technologies, and approaches to problem-solving that can have a profound impact on society. Then, institutions can hopefully equip students with the skills and knowledge they need to succeed in an increasingly complex and interconnected world. A belief then is that universities will be better positioned to prepare students to tackle complex challenges in their future careers by enabling them to work across multiple fields and with people from diverse backgrounds (Chalah, Hwang, & Habbal, 2016; Sheets, 2016).

But the question is "is it really possible to provide transdisciplinary learning around topics of convergence in higher education today?" It would appear from this design-based research project that large-scale research institutions are not likely structured in a way to readily bring transdisciplinary programs into existence. There are several institutional barriers that must be overcome for authentic transdisciplinary learning to occur. For example, there are siloed academic departments that isolated from each other, a lack resources to support faculty in collaborating and working across disciplines (e.g., co-teaching courses can appear to be a drain on resources as it takes time away from two faculty members instead of one), disincentives for engaging in transdisciplinary work as rewards/recognitions are focused on individual

achievements of faculty and departments, and sometimes there is general resistance to changing the way in which teaching has always been done.

To overcome these institutional barriers, universities would need to decide to commit to transdisciplinary learning and subsequently allocate the resources to support the convergence of disciplines in both research and teaching. However, even if this commitment is made, there are still several factors to consider. As found through this research project, in order for transdisciplinary programs to exist, they will first need to have a clear purpose related to a topic that exists outside of traditional disciplines and then the learning experience will still need to be tied to credentials that are recognizable to students/advisors/employers. In addition, universities will need to consider new ways incentivize transdisciplinary programs or educational innovations in general. These incentives could include different departmental funding models (e.g., funding based on student credit hours rather than solely on enrollment numbers within a major) as well as values for faculty to engage in the scholarship of teaching/learning (Asarta et al., 2018). Lastly, as working across academic disciplines is complicated, the university commitment could include a new organizational structure to stand alongside the academic disciplines to 1) streamline curricular processes/approvals and 2) provide space for programming that exists across academic units—minimizing academic territory disputes. Without this structure, it is likely that any educational innovations will not be explored/tested as the time needed and academic challenges faced will be too much for any individual faculty or departments to take on. Then, with these supports, disciplines can be valued equally and offered a place to converge, and the resulting educational programming can help to foster a sense of belonging from students across all backgrounds in the resolution of the challenges facing themselves and the world around them. Although making headway toward educational transformation, specifically related to transdisciplinary learning, is difficult, the learning value for students seems to make it worth exploring new ways for approaching undergraduate education. In a time when the value of higher education continues to be questioned, it may be time to rethink undergraduate education and potentially rebalance investments and value systems across research, learning, and engagement.

Acknowledgments
The research reported in this paper was supported in part by the U.S. National Science Foundation (NSF) under the award DUE #2044288. This content is solely the responsibility of the authors and does not necessarily represent the official views of the NSF.

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