PREPARING STUDENTS TO DESIGN RESILIENT RECEIVING COMMUNITIES THROUGH TRANSDISCIPLINARY COLLABORATION

BLAKEMAN, HALEY, FASLA, PLA
Robert Reich School of Landscape Architecture, Louisiana State University, Blakeman1@lsu.edu

BIRCH, TRACI, PhD, AICP
Coastal Ecosystem Design Studio and School of Architecture, Louisiana State University, Tbirch@lsu.edu

ABSTRACT
By 2050, approximately 1.2 million people in Louisiana will be at risk of coastal flooding due to coastal hazards and relative sea level rise (CPRA 2017). While Louisiana's communities are losing land faster than most, climate change is expected to displace tens of millions of people nationally. Some residents will adapt in place, and many will move over time to less vulnerable inland communities. While there is much discussion of managed retreat, the concept of receiver communities—strategically designed places intended to absorb populations in a safe and culturally appropriate manner—is in its infancy. Climate change is often referred to as a "wicked problem" because its impacts are complex, overwhelming, and intertwined. New ways of thinking and problem-solving are needed to address its impacts. Using design thinking and transdisciplinary collaboration, landscape architecture and architecture faculty at Louisiana State University have developed a model for design studios that advances long-term resilience in communities receiving coastal migrants. Multidisciplinary teams of landscape architects, interior design, and architecture students employed this strategy in potential receiver communities of Jennings and Vinton, Louisiana. Student surveys indicate positive outcomes for both students and communities, including a deeper understanding of complex issues, innovative solutions, and stronger designs with multiple benefits.

Keywords
Climate change adaptation, transdisciplinary, design thinking, community planning, receiving communities

1 INTRODUCTION

Earth's climate is changing, raising a multitude of associated problems for society. Addressing complex problems such as this requires syntheses of ideas and development of solutions across a vast set of disciplines including natural and social sciences, engineering, and the humanities (Oxman, 2016). The development of scientific knowledge related to climate change processes and future impacts has increased considerably in recent years, but necessary adaptive actions are often rather limited (Olofsson 2015). As climate impacts intensify, the need for professionals who can collaborate across disciplines and knowledge systems to address these challenges becomes increasingly necessary. Unfortunately, most climate-related disciplines have narrow training, meaning that professionals are not equipped to bring their skills to the table with interdisciplinary teams to help solve multidisciplinary problems. While higher education arguably created the silos that make interdisciplinarity difficult, it also offers a unique opportunity to model and teach the skills necessary to understand future threats and collaborate across disciplines and sectors to address the climate crisis (Mooshavi & Bush 2021, Olofsson 2015).

The following work presents experiences to date from research funded by the Gulf Research Program of the National Academies of Sciences, Engineering, and Medicine (GRP). The GRP was established in 2013 following the British Petroleum Oil Spill to support applied research that advances science, engineering, and public health knowledge to reduce risk in the Gulf of Mexico Region (NAS GRP 2024). The work presented here specifically relates to GRP workforce education efforts intended to prepare the next generation of design professionals to bridge disciplinary divides between science and community and address the major issues facing the Gulf region now and in the future. Operating from a pedological constructivist approach, the work presented here engaged graduate and undergraduate architecture, landscape architecture, and interior design students from Louisiana State University in a series of courses and assignments intended to build capacity to identify, visualize, explore, and propose solutions to critical local and regional climate issues in Louisiana. The frameworks prioritized in this work include design thinking and transdisciplinary approaches. Our goal was to introduce students to unique learning environments and opportunities and to build on cross-learning opportunities within and external to the design fields, to develop the skills to needed to address current and future climate challenges in the state.

1.1 Literature review

Climate change is a complex and challenging problem for communities, typical of what Rittel and Webber (1973) called *wicked problems*. Climate impacts vary spatially (e.g. sea level rise, wildfire, drought, extreme heat, etc.) and temporally, and are impossible to address in a simple or final way. Uncertainties regarding probable impacts, the scale of interventions, and the effectiveness of proposed solutions require cross-disciplinary and collaborative reasoning processes to develop long-term, future-focused, and adaptable solutions (Dubois et al., 2016) that meet societal needs and values (Adger et al 2009). While uncertainties abound, it is widely acknowledged that climate-focused strategies will require both mitigation and adaptation actions from the local to global scales (IPCC 2023).

Design Thinking: Design processes require qualitative and quantitative information, critical and creative ideation techniques, and the ability to find a range of alternate solutions to meet societal needs (Ghonim 2016). The process by which these solutions are developed is called design thinking. Design thinking theorizes design as an alternative decision-making process addressing complex problems for which there is no "right or wrong" answer–but rather a range of answers based on goals, objectives, and preferences (Dorst 2011). To prepare future generations of design and science professionals to address climate change, it's necessary to incorporate human-centered design thinking and iterative problem solving within higher education (Moosavi & Bush, 2021). Design thinking prioritizes using lived experiences to address issues, stresses the importance of empathy and integrated approaches to outlining goals, objectives, and solutions (National Academies of Sciences, Engineering, and Medicine et al., 2018). Participants in this process use design as a method and catalyst for organizational and community change, while also encouraging collaborative efforts towards their specified goals. Aside from aiding in the classroom topics, this human-centered thinking can further enhance and affect the public sector and government services. Research from Liedtka et al. in "The Use of Design Thinking in the U.S. Federal Government" (2020) utilizes this idea to highlight positive implications in the public realm and how these benefits reach communities. According to research by Park and Lee (2022), Moosavi and Bush (2021), and Gonen

(2019), individuals who encounter a design thinking approach in design education exhibit enhanced understanding of an issue and innovative ideas and products. Park and Lee (2022), as well as Casakin and Wodehouse (2021), argue for educational experiences that not only foster innovation, but also instill a sense of ethics and social responsibility while optimizing collaborative interdisciplinary opportunities.

As noted above, couching research and problem solving through a design thinking lens leads to the use of design as a method of creative problem solving as well as a catalyst for organizational and community change. Through the lens of design thinking – we can hope to move past the rut of incrementalism that enforces past mistakes and makes innovative solutions difficult to imagine except in the face of climate change. The very nature of the course presented here – one that engages a range of students, academics, subject matter experts, and community members – was intended to push students to develop innovative approaches to problem solving (e.g. architecture students were exposed to the rigor of landscape architecture projects' site analysis and design proposals, as well as the feasibility of implementation through civil engineering hydrologic modeling). The ability to coordinate courses across the university - and semesters - means students were able to dive deeper into foundational concepts and will be able to bring their ideas closer to implementation (which is rare for college students).

Transdisciplinary Approach: Recent managed retreat research supports the inclusion of more diverse expertise (Tubridy, Lennon, and Scott 2022). A transdisciplinary approach promotes integrative activity, reflection, and practice, rising above the established limits of each discipline to solve complex problems that escape conventional intervention (Stenner 2014). While interdisciplinary processes coordinate and share among disciplines, a transdisciplinary approach transcends disciplines, opening novel spaces for additional voices, methodologies, and practices beyond disciplinary norms (Nicolescu 2002; Stenner and Taylor 2008). A transdisciplinary team relates all disciplines into a coherent whole (McGregor 2004). Transdisciplinary research and design processes joins scholars, practitioners, and communities to create resilient designs with multiple community benefits.

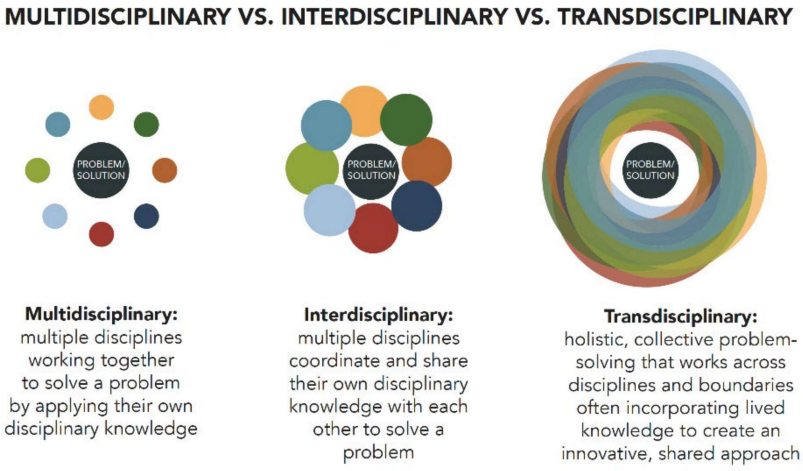

Figure 1. Multidisciplinary vs. interdisciplinary vs. transdisciplinary collaboration

Collaborative experiences across disciplines have become increasingly popular teaching methods due to positive results and the evidence of benefits towards these integrated learning approaches. Studies show positive student outcomes relating to mastery of topics, student outcomes, problem solving, communication skills, and motivation towards learning (Skorton 2019). Skorton (2019) goes further to recommend support and removal of barriers towards integrated learning to encourage and facilitate further collaboration. Moosavi and Bush (2021) posit that transdisciplinary educational approaches could enhance and provide complementary knowledge, especially regarding sustainability topics and the complexities surrounding these challenges and issues. The work "Strengthening Sustainability Programs and Curricula at the Undergraduate and Graduate Levels" by the National Academies of Sciences (2020) expands on the necessity of transdisciplinary collaboration within climate change concepts and topics, calling on faculty to collaborate with sustainability professionals to prepare students for future real-world

climate change challenges in their careers. These collaborations can be models for students for their own collaboration within the classroom while offering knowledge from outside the students' discipline.

Despite a growing understanding of the importance of transdisciplinary knowledge production for both climate adaptation and community transformation, early career design professionals typically lack opportunities to practice these approaches within their normal education and professional development (Feagan et al. 2023). When it comes to managing it, design thinking and transdisciplinary methods require meaningful and active engagement of a wide range of stakeholders in order to get to a design product that meets community needs and values. This is not a straightforward task, as historically, design processes and traditional participatory requirements meant an expected separation between professionals (e.g. architects, landscape architects, urban designers) and end users. This expected separation is often ingrained early in design education and continues into early career opportunities. However, the LSU model builds on a concerted effort in the Gulf of Mexico region to shift the relationships between design professionals and citizens to a model that recognizes the vital role each plays in adapting to climate change.

Figure 2. Results of incorporating design thinking and transdisciplinary collaboration to address impacts of climate change

1.2 Research questions

From the recognized need to address issues of climate change and managed retreat, the research team framed coursework and research around the following questions:

1). How can we train design professionals to lead climate change adaptation and resilience?

2). How can we coordinate academic research, classroom projects, and grant procurement to achieve a more robust research product and knowledge base for students?

2 METHODS

The Mississippi River Delta and coastal Louisiana are disappearing at an astonishing rate: an American football field of wetlands is lost every 100 minutes. Since the 1930s, Louisiana has lost over 2,000 square miles of land and another 1,700 square miles are at risk of loss over the next fifty-years (Couvillion et al., 2017). As land loss and repeated impacts from storms are forcing residents to consider retreating to safer locations. While there is much discussion of managed retreat, the concept of receiver communities—strategically designed places intended to absorb populations in a safe and culturally appropriate manner—is in its infancy. With climate change expected to displace tens of millions of people nationally, communities and the people who design them will need to think differently about how to absorb residents escaping creeping floods and worsening storms.

The overarching goal of this work is to provide capacity to those places in south Louisiana least likely to receive the technical support necessary to develop design strategies, advocate for investment, and realize resilient outcomes. Climate change, and its policy and development frameworks, require both design thinking and complex transdisciplinary solutions. The courses, learning opportunities, and processes engaged students from various backgrounds; and projects and ideas were structured around breaking down academic silos. We also engaged community stakeholders (e.g., non-profit organizations, elected officials, culture bearers, and community members) from the beginning of the design process to teach students the value of local knowledge and co-design (see Section 2.2). We did this through stakeholder engagement, organized community field trips, and design charrettes (see Section 2.2), as well as invited speakers from academia and practice to link classroom lessons to issues being addressed statewide and in their fields. Including professionals, partners, and community stakeholders added knowledge to students' individual expertise. The goal was for teams to create a common language, understanding, and process that transcended their individual disciplines.

Students analyzed resilience gaps in Vinton and Jennings, Louisiana to address with their designs. Community members were directly involved with the process through interviews, small group meetings, site visits, and design reviews to weigh in on design decision-making and become the champions of designs that reduce risk and improve quality of life once these students graduate. Experts in the field shared their expertise to help inform and guide students' recommendations. Feedback from mayors, funders, and partners, as well as a student survey, helped faculty gauge success and adjust delivery.

2.1 Applying research to student projects

The LSU teaching model employed transdisciplinary collaborations and design thinking to increase long term resilience in potential receiving communities in south Louisiana, Vinton and Jennings. *Louisiana Receiving Communities* (Blakeman, 2022) was used as the resilience framework for the class. This report identifies social, environmental, and economic factors that affect a resident's ability to not only bounce back from disasters but also thrive in a new community. These resilience factors (see Table 1) identify common issues affecting climate change migrants and how receiving communities could better support them when they move. This study showed that if we proactively plan for relocation using this strategy, we can attract people dislocated by climate change while improving the quality of life for all residents. Because students were from various disciplines—interior design, architecture, and landscape architecture—these resilience factors gave teams a common language to identify ways to increase community resilience.

Using design thinking and transdisciplinary collaboration, students worked in communities in south Louisiana to propose community improvements that met specific resilience gaps. Vinton and Jennings were identified as potential receiving communities through working with the mayors at the CEDS Louisiana Community Resilience Institute. Students applied the resilience factors (Table 1) to assess each community's resilience gaps. Their analysis showed Jennings had ample support for climate migrants because of its strong economy, growth potential, and charm. At the same time, Vinton lacked many of the support systems needed to become a resilient receiving community.

Table 1. Resilience factors.

Resilience Factor	Social	Environmental	Economic
social services	•		
food banks	•		
healthcare access & quality	•		
education access & quality	•		
community cohesion opportunities	•		
flood risk		•	
prime agriculture land		•	
sensitive habitat protection		•	
air & water quality		•	
evacuation route proximity		•	
cultural identity & sense of place			•
transportation infrastructure			•
economic diversity & job training			•
expansion potential & future planning capacity			•
housing costs, variety & quality			•

Faculty in architecture and landscape architecture held a joint studio with 23 landscape architecture, 12 architecture, and four interior design students to propose projects that increased resilience in the two potential receiving communities. Working with one well-positioned community as well as one with many resilience gaps gave students the opportunity to propose ideas that had multiple benefits. This process allowed them to apply the concepts discussed and the data they collected. Students worked in teams with students from each discipline. This studio focused on planning and design from the regional to the site scale, emphasizing co-production principles, resilience strategies, and development methods informed by the region's ecology, culture, and economy. Student learning objectives included 1) Translate systems research into design and climate adaptation decision-making; 2) Engage community stakeholders and incorporate local knowledge into design; 3) Engage and experiment with transdisciplinary methods and education models; and 4) Create a common language across disciplines to improve communication, engagement, and visualization skills.

The class started by discussing what natural, built, and socioeconomic factors make a community more vulnerable, especially in the context of climate change. Students were asked to fill out a matrix to identify their skillsets and took a personality quiz. Faculty then used the results of both to make teams with broad skillsets and complimentary personality traits to break down disciplinary silos and focus on the skills each student could contribute instead.

Teams of students then outlined 10 attributes for strong, less vulnerable communities based on the resilience factors in Table 2. They used GIS and U.S. Census data to analyze Vinton and Jennings' resilience gaps. Invited speakers shared their research and expertise in Louisiana coastal protection efforts, preserving arts and culture as people move, and why individuals decide to leave the coast. Students participated in organized field trips, interviews with residents and approximately 40 high school students, and meetings with mayors and staff to gain local knowledge and co-design for their future. Figure 3 and Figure 4 show examples of student teamwork. Students from multiple disciplines worked in groups collaboratively and reflected on and incorporated what they learned from community engagement into their design work. When possible, faculty rearranged classrooms to create workspaces that encouraged collaboration and design exploration.

Students were asked to identify an overarching theme for their work that addressed resilience gaps identified in stakeholder interviews and data collection. Students proposed themes that were not discipline specific, but instead broad frameworks that connected their individual design proposals. Some teams did quick individual designs and reconvened to talk through multiple options. While this helped generate ideas, they found it difficult to land on a cohesive theme. However, the teams that emerged with the strongest themes (Figures 3 and 4) talked through the resilience gaps together around a single table, illustrating their ideas on a shared map with many iterations.

Identifying a framework was difficult for most teams, as it needed to be broad to address complex and intertwined issues that they did not fully understand, yet simple enough to guide their individual designs within a cohesive team proposal. For instance, one team focused on the health of Vinton (Figure 3). Their resilience factors analysis and stakeholder interviews showed the need for an improved economy, flood reduction, recreational opportunities, social gathering spaces, and social support services. They proposed a greenway system through and around town to manage stormwater and link a community resilience hub with social services and disaster response assistance, streetscapes with infill businesses and housing, a business incubator, and a nature park. The result was a cohesive system that increased Vinton's resilience by supporting its people, economy, and environment.

Figure 3. Designing for Health in Vinton: People, Economy, & Environment (2023). Willow Cook, Leah Leblanc, Sydney Milligan, Jerund Sanders, and Eric Vanbergen.

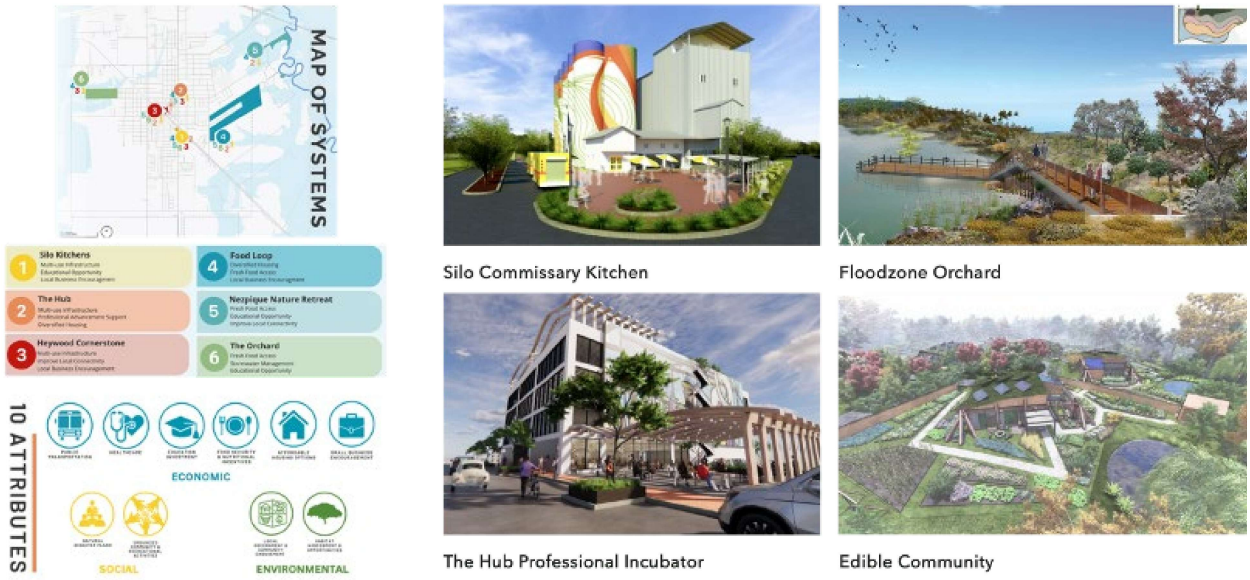

Figure 4. People to Plates: Preserving Culture of Jennings Through Cooking (2023). Sofia Alves, Catherine Hebert, Clayton Kimball, Nina Kirsch, and Kaleigh Lilly.

Another team was struck by the juxtaposition of Jennings' strong tie to Cajun culture and food, with the lack of fresh food access in the region. They used a framework of food to preserve Cajun culture, bring people together, and improve health to increase resilience. They proposed six nodes including a food hub with an industrial kitchen to encourage local businesses, a floodable orchard for fresh fruit and stormwater management, access to the river, and a community centered around edible landscapes (Figure 4).

2.2 Funded research for application

Teaching this way is expensive and time-consuming. Coordinating with other faculty takes extra time, and much of this work is done over the summers when institutions do not pay faculty. Studio spaces also need to be upgraded to accommodate teamwork and community engagement. Site visits and engagement with professional experts are often an added expense. Multi-year funding is needed to support this highly interactive work from research to implementation.

Studio projects resulted from the Louisiana Community Resilience Institute, which invites six mayors each year to identify resilience projects in their communities. The LSU Coastal Ecosystem Design Studio (CEDS) led the workshop funded by Sea Grant, the Federal Emergency Management Agency, and the State of Louisiana Office of Community Development. Participants use resilient community design methods to address the challenges of communities impacted by climate change. By pairing political leaders with professional experts, this workshop gives elected officials a better understanding of design, planning, and hazard mitigation's role in improving community resilience, increasing their capacity to tackle complex resilience issues.

The National Academy of Sciences Gulf Research Program (NAS-GRP) funded the Vinton and Jennings studio as a part of the Gulf Futures Design Studios pilot grant. Five universities across the Gulf Coast focused on pairing design thinking with scientific data to catalyze innovative solutions to climate change's effects on Gulf coast communities. This grant covered all travel for the studio, community presentations, a graduate assistant, report preparation and printing, and presentations at conferences to share the work with scientists working on the Gulf Coast. NAS-GRP recently extended this program for another three years, allowing Blakeman and Birch to work in six additional communities to refine this methodology and process.

3 RESULTS

Communities adapting to the impacts of climate change need robust solutions. Scientific data coupled with design thinking and transdisciplinary collaboration bring multiple expertise together in an iterative process to provide many potential solutions with multiple benefits. In addition to helping communities, students expand their knowledge base and are better prepared to address the impacts of climate change.

3.1 Incorporating resilience factors in design

The students used the resilience factors from *Louisiana Receiving Communities* to analyze Vinton and Jennings ability to support people migrating from the coast. This data, along with interviews and community input summaries, also helped students identify resilience gaps they likely would not have found or addressed in their individual disciplines. This also gave teams a common language to inform their overall theme that set the stage for robust solutions with multiple benefits. Examples from student projects included incorporating schools, daycares, mental health, and social service support, clinics, recreational facilities and regional parks, farmer's markets, cultural centers, aquaculture, stormwater management and green infrastructure, alternative transportation systems, resilience hubs, and a range of housing choices. Linking identified resilience gaps with the specific facilities needed resulted in a richer project that met the community's needs. In addition, working with community input from a real project highlighted current environmental justice and equity issues that landscape architects must be prepared to address. As a result, students became civic-minded, empathetic designers using design thinking and iteration to solve larger social and economic challenges.

3.2 Understanding through design thinking

While students learned a lot about Vinton and Jennings through data collection, they came to understand the two places through iterative design. The most successful teams shared their ideas and got feedback from their peers on their designs weekly. Students also informally presented to their professors every two weeks. These presentations were conversational, yet in depth. Each time, students were asked to clarify their themes and review their designs. During these meetings, their teammates and professors gave feedback, and students continually adjusted their proposals.

3.3 Transdisciplinary moments

During the first part of the semester, students from all three disciplines felt out of place and overwhelmed by the community scale and the complexity of the issues. It was difficult for them to think at a systems level until they worked together to shape their team's theme. The teams that worked out their theme collaboratively were able to create strong designs that fit within the team's framework, resulting in a cohesive overall project.

Each discipline also brought overarching concepts that guided how their teammates incorporated resilience into their individual designs. For instance, the interior design students shared guidelines on creating people-centric spaces which influenced designs for parks, plazas, buildings, and streetscapes and linked interior and exterior spaces. The landscape architecture students helped classmates understand natural systems, which were used to link nodes, provide recreational opportunities, preserve habitat, and reduce flooding. Architecture students shared guidelines on urban infill and appropriate material selection with classmates, which helped others produce cohesive designs with a sense of place. Once we broke down the silos, students found they were interested in designing spaces they typically did not address in their disciplines. Architecture students designed nature parks and stream restorations, interior design students tried their hand at outdoor plazas and streetscapes, landscape architects collaborated on large scale developments.

While the data gathered from the resilience factor analysis and expertise from their peers gave students a lot of information about Vinton and Jennings, the input and feedback they got from residents, business owners, the mayors, city staff, and high school students helped the students understand what it is like to live in Vinton and Jennings. As a result, their designs were tailored to the people of Vinton and Jennings, helping these communities retain and support their residents long term.

3.4 Student survey results

As a follow up to the multi-disciplinary studio that focused on Vinton and Jennings, the faculty surveyed the students about their experience compared to other discipline-specific studios they have participated in previously to gauge what they had learned. Their responses were used to structure future multidisciplinary coursework moving forward. Students were asked the following questions: 1) What is the value of the transdisciplinary approach? 2) What did you learn from a peer in this process? 3) What did you learn about yourself in this process? 4) Do you have any suggestions on how we could improve this transdisciplinary studio? 5) What might you bring from this experience to working in a firm or company in the future? Themes from their responses are below.

Communication is key: Communication was a common theme in students' assessments. While landscape architecture, architecture, and interior design are related, each approaches process, ideation, goals, and addressing space quite differently, and their strengths are not the same. Finding common language was also a challenge, but students learned to bridge gaps in communication and methodologies. They also worked at communicating complex concepts clearly and in simple terms to others with different expertise, training, and language. Updating collaborators on progress and getting feedback regularly instead of working independently with the assumption that teammates understood their direction helped them stay coordinated. Some students found leadership skills they didn't know they had by bringing others together. Good leadership was defined by effective communication that led to a cohesive team and design proposal.

The student becomes the teacher: Several students noted that they learned substantial amount more in this class than previous semesters because of how much time they spent collaborating. Each has specific technical and conceptual knowledge which broadened teammates' thinking. Their peers became their teachers, as they shared principles and application from their respective disciplines, such as landscape ecology or structural systems that improved their designs. This also allowed groups to be self-sufficient ad creative in new ways. Partners also encouraged each other when they became frustrated and offered a different viewpoint when they became stuck.

Variety of expertise is needed : Multiple disciplines are necessary to thoroughly analyze and design for complex problems like climate change adaptation. Students pointed out that a transdisciplinary approach enables deeper understanding of multifaceted issues by leveraging insights, methodologies, and perspectives from multiple fields. When one discipline overlooked or was not equipped to handle a site challenge, a teammate in another discipline stepped in with a new approach. Furthermore, a student noted that "collaboration sparks creativity and innovation, creating novel, impactful, and effective solutions instead of siloed projects."

Sum is better than the parts: Students learned to think beyond each disciplines' framework and to merging methodologies to find the best solutions. Teams with multiple disciplines had comprehensive insights, while each individual contributed to a cohesive design proposal for each town. One student also pointed out that the results of group discussions were often better than what they would have achieved on their own. Groups that worked as a single unit and agreed on a theme early felt that their projects stayed more focused.

Ways to improve : Because we all approach a design problem differently, students noted that reviewing common language, process, and overall approach at the beginning of the semester would help teammates understand their partners' perspectives and how to engage them in solving issues. In addition, it was clear that the teams that had representation from architecture, landscape architecture, and interior design had stronger designs with multiple benefits. On the other hand, less integrated teams lacked direction, had less cohesive proposals, and learned less from their peers. Several students on the less integrated teams noted that the teams with members from all three disciplines made more progress through the relationships they built by teaching each other.

Preparing professionals: Perhaps most importantly, students reported that this experience prepared them to be successful and collaborative practitioners. One noted that the knowledge gained from teammates in other disciplines will allow them to function better within their field. Another gained "a collaborative mindset, problem-solving skills tailored for complex challenges, and adaptability". Finally, another said the experience will help them "foster a culture that embraces diverse perspectives, driving innovation and creativity within [my future] organization."

4 DISCUSSION

Universities and funders are striving for a better prepared next generation of design and urban development-related professionals with the capacity to identify, visualize, explore, and propose design thinking and transdisciplinary solutions to community resiliency in the Gulf of Mexico. Not only will this approach ground design proposals in science and lived experience, but it will also encourage scientists to explore many options through iterative problem-solving instead of testing a single hypothesis.

The very nature of these courses that engage students, academics, professionals, and community members is intended to push students to develop innovative design practices through iteration and design thinking. Coupling the design process with data and local knowledge allows for innovative resilience systems that meet multiple needs. These courses provided learning opportunities and processes engaging students from various backgrounds, and projects and ideas structured around breaking down academic silos.

Working in communities with real stakeholders encouraged tangible solutions and allowed students and interns to fully understand how their designs can balance resilience, aesthetics, and service to residents. Furthermore, applying research to real community issues allows students to gain a toolkit grounded in best practices and the products of that research are more useful. In addition, testing research theories and results on real projects with students improves and informs our research. This process connects theory to practice, real world problems, and people.

4.1 Ways to Improve

As we aim to continue doing this work, several adjustments would improve the process and further support communities, students, and faculty. As noted, the teams with fewer disciplines represented were not as successful. We will be deliberate about team composition, so all disciplines are represented, as well as incorporating students from physical and social sciences. This will be incorporated in the studio in the fall, but classroom spaces are not well outfitted to support collaborative learning and are rarely able to accommodate community partners in design processes. We plan to retrofit classrooms to add collaborative spaces, moveable furniture, and interactive tools to encourage the flow of people, conversations, ideas, and information. Finally, following student design proposals, communities with little capacity and small budgets need implementation support including additional community meetings, a next steps action plan, detailed design, and access to grants. Blakeman and Birch recently received a NAS-GRP grant to further support implementation following students' designs.

4.2 Benefits

While this type of learning environment is more time and effort for faculty, the benefits are exponential and necessary to prepare our students to address the effects of climate change on communities. When students gain a new understanding of the multiple aspects of resilience, they can propose multi-beneficial solutions. For example, they can champion the integration of spaces that bring people together to build community cohesion, natural systems into development, and social support services in every project. This approach also builds relationships with stakeholders and experts in other fields that will continue to influence their work as designers.

Working with researchers, faculty, and students in these community-based resilience studios give municipalities access to funds, expertise, and holistic solutions that they would likely not have access to or be able to afford. The methodology used meets communities where they are and improves resilience incrementally based on their specific gaps so they can better support current and future residents. The co-design process also empowers residents to work with technical experts to envision and illustrate what a resilient future might look like for their town. These student-led visioning projects are often the first step to building support for professional design services and implementation grant applications. In phase two of this grant, Birch and Blakeman worked in funds to assist with next steps, grant applications, and project implementation to support communities with little capacity.

5 CONCLUSION

This class was a trial as a part of the National Academies of Science – Gulf Research Program (NAS-GRP) Gulf Futures pilot program. While Birch and Blakeman strived to incorporate transdisciplinary collaboration and design thinking into designing for resilient receiving communities, some things worked, and some did not. Mixing the teams based on skill set broke down silos and using the resilience factors provided a common language to analyze communities. Field work, community engagement, and iterative design helped students gain a deeper understanding of the issues when coupled with data they could gather remotely. However, the studios were divided into two rooms, with half of the teams in each. Several teams would meet for a few minutes to coordinate, then return to their "home" discipline studios to work. Their projects were not as cohesive as students that collaborated throughout studio. Another challenge was the lack of capacity for Vinton and Jennings to apply for grants and implement projects.

Blakeman and Birch just received a three-year NAS-GRP grant to continue this program. This grant includes funds to assist communities with further community engagement and implementation assistance.

In addition, the studio was moved to one larger space with group tables to encourage collaboration and group exploration. Other disciplines across campus will be engaged to broaden the transdisciplinary collaboration and improve recommendations.

People are leaving our most vulnerable coastal communities, and studies show tens of millions will follow as sea levels continue to rise. Where will they go and how will we support them? It is a complex issue that needs new ways of understanding, innovation, and novel solutions. To achieve those goals, we must change how we research and educate to train future practitioners to lead climate change adaptation and resilience. Design thinking and iterative problem solving from design professionals like landscape architects, planners, architects, and interior designers is needed to explore a variety of adaptation solutions. The expertise of geographers, sociologists, social workers, anthropologists, political scientist, coastal scientists, hydrologists, ecologists, agriculturist, and environmental policy makers is also necessary to help communities fully address all of the issues exacerbated by climate change and resettlement. This is especially true as people migrate from their coastal homes to new communities where they may not have employment options, social networks, adequate housing, or social services support.

If we want positive outcomes and reduced risk for people who migrate, we must proactively plan for resettlement in a way that supports long term resilience. Understanding which communities are already better equipped to receive people can help direct people to places that can support them. Understanding resilience gaps help direct funding to support both current and future residents. Taking to account the multiple aspects of resilience helps designers propose projects that have multiple social, economic, and environmental benefits that increase overall community resilience.

Universities should incorporate transdisciplinary and co-design frameworks and methodologies into design and science curriculums so students, community stakeholders, and resource agencies can collaboratively address issues of risk and resilience. In order to support this approach, faculty must strategically maintain and expand cross-disciplinary collaborations between designers and scientists to support community-based design education, community partnerships, and valuable outcomes to address regional climate impacts.

To truly serve communities struggling to adapt to climate change, faculty need to develop and maintain strong community partnerships that provide capacity and support. These relationships are time-consuming but necessary to understand their needs and desires. Finally, long-term financial support for faculty is necessary to make this approach to co-production and design education an accessible research and teaching focus. It is also necessary to retrofit classroom spaces into collaborative places. To facilitate faculty grant opportunities, universities and academic units must cultivate relationships with funders supporting climate change research, application, and implementation. Testing research through student-led community projects also allows researchers to apply theories and methodologies, resulting in more robust research products. Coordinating research, education, and application grounds theory and research in the practice of landscape architecture so we continue to push our profession forward. Above all, design students share the desire to make the world around them better. Teaching them to combat climate change with research-backed iterative design and collaboration empowers them to make the change they desire and that our residents need to protect their culture, livelihoods, and community.

REFERENCES

Blakeman, H. (2022*). Louisiana receiving communities: prioritizing communities and reducing environmental, social, and economic risk.* (Technical Report). Louisiana State University. Retrieved from: https://coastal.la.gov/wp-content/uploads/2023/08/Potenital-Louisiana-Receiving-Communities-Report.pdf

Casakin, H., & Wodehouse, A. (2021). A systematic review of design creativity in the architectural designstudio. *Buildings*, 11(1), Article 1. https://doi.org/10.3390/buildings11010031

Coastal Protection and Restoration Authority of Louisiana. (2023). *Louisiana's comprehensive masterplan for a sustainable coast.* Coastal Protection and Restoration Authority of Louisiana. https://coastal.la.gov/wp-content/uploads/2023/06/230531_CPRA_MP_Final-for-web_spreads.pdf

Couvillion, B. R., Beck, H., Schoolmaster, D., & Fischer, M. (2017). *Land area change in coastal Louisiana (1932 to 2016)* (Report 3381; Scientific Investigations Map). USGS Publications Warehouse. https://doi.org/10.3133/sim3381

Dorst, K. (2011). The core of 'design thinking'and its application. *Design studies*, *32*(6), 521-532.

Dubois, C., Cloutier, G., Rosenkilde Rynning, M. K., Adolphe, L., & Bonhomme, M. (2016). City and building designers, and climate adaptation. *Buildings*, *6*(3), 28. https://doi.org/10.3390/buildings6030028

Feagan, M., Fork, M., Gray, G., Hamann, M., Hawes, J. K., Hiroyasu, E. H., & Wilkerson, B. (2023). Critical pedagogical designs for SETS knowledge co-production: online peer-and problem-based learning by and for early career green infrastructure experts. *Urban Transformations*, *5*(1), 6. https://doi.org/10.1186/s42854-023-00051-1

Ghonim, M. (2016). Design thinking in architecture education: Issues, limitations, and suggestions. 553–561.

Gonen, E. (2020). Tim brown, change by design: how design thinking transforms organizations and inspires innovation (2009). *Markets, Globalization & Development Review*, *4*(2). https://doi.org/10.23860/MGDR-2019-04-02-08

Liedtka, J., Sheikh, A., Gilmer, C., Kupetz, M., & Wilcox, L. (2020). The use of design thinking in the US federal government. *Public Performance & Management Review*, *43*(1), 157-179. https://doi.org/10.1080/15309576.2019.1657916

McGregor, S. L. T. (2004). *The nature of transdisciplinary research and practice*. Kappa Omicron Nu Human Science Honor Society. https://publications.kon.org/resources/the-nature-of-transdiscipliary-research-and-practice.html

Moosavi, S., & Bush, J. (2021). Embedding sustainability in interdisciplinary pedagogy for planning and design studios. *Journal of Planning Education and Research*, 0(0). https://doi.org/10.1177/0739456X211003639

National Academies of Sciences, Engineering, and Medicine. (2020). *Strengthening sustainability programs and curricula at the undergraduate and graduate levels*. The National Academies Press. https://doi.org/10.17226/25821

National Academies of Sciences, Engineering, and Medicine, Health and Medicine Division, Board on Global Health, & Global Forum on Innovation in Health Professional Education. (2018*). A design thinking, systems approach to well-being within education and practice: Proceedings of a workshop* (E. H. Forstag & P. A. Cuff, Eds.). National Academies Press (US). http://www.ncbi.nlm.nih.gov/books/NBK540868/

National Academies of Sciences, Engineering, and Medicine, Gulf Research Program. "About - Gulf Research Program." https://www.nationalacademies.org/gulf/about. Accessed 24 August, 2024

Nicolescu, B. (2002). *Manifesto of transdisciplinarity*. State University of New York Press.

Olofsson, Jörgen, et al. "Educating the next generation decision makers - the multi-disciplinary classroom as a platform for developing communication skills needed for future progress of adaptation measures." *ECCA Copenhagen 2015 (2nd European Climate Change Adaptation conference)*. 2015.

Oxman, N. (2016). Age of entanglement. *Journal of Design and Science*. https://doi.org/10.21428/7e0583ad

Park, E. J., & Lee, S. (2022). Creative thinking in the architecture design studio: Bibliometric analysis and literature review. *Buildings*, *12*(6), 828. https://doi.org/10.3390/buildings12060828

Pierce, D., Davies, M., & Kryder, B. (2019). Innovate with design thinking in the sport management capstone course. *Sport Management Education Journal (Human Kinetics)*, *13*(1). https://doi.org/10.1123/smej.2018-0018

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences*, *4*(2), 155-169. https://doi.org/10.1007/BF01405730

Skorton, D. (2019). Branches from the same tree: The case for integration in higher education. *Proceedings of the National Academy of Sciences*, *116*(6), 1865-1869. https://doi.org/10.1073/pnas.1807201115

Stenner, P. (2014). Transdisciplinarity. In T. Teo (Ed.), *Encyclopedia of Critical Psychology* (pp. 1987–1993). Springer New York. https://doi.org/10.1007/978-1-4614-5583-7_317

Stenner, P., & Taylor, D. (2008). Psychosocial welfare: Reflections on an emerging field. *Critical Social Policy*, *28*(4), 415–437. https://doi.org/10.1177/0261018308095278

Tubridy, F., Lennon, M., & Scott, M. (2022). Managed retreat and coastal climate change adaptation: The environmental justice implications and value of a coproduction approach. *Land Use Policy*, *114*, 105960. https://doi.org/10.1016/j.landusepol.2021.105960