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Broadening Participation Research Project: Charting a Path to Transdisciplinary Collaborative Design

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Charting a Path to Trans-disciplinary Collaborative Design

Introduction

A recent National Climate Assessment (NCA), representing the work of more than 300 scientists under a Federal Advisory Committee and a review panel of the National Science Foundation, devoted a chapter to "Research Needs" for the future, specifying "cross-cutting foundational research capabilities" to "integrate natural and social science, engineering, and other disciplinary approaches" and "build capacity for climate assessment through training, education, and workforce development." Realization "requires new approaches to training and curriculum, as well as research to evaluate the effectiveness of different approaches to research and teaching [1]."

Charting a Path to Trans-disciplinary Collaborative Design, is a current NSF project that will evaluate, test, and model pedagogic methods in an existing interdisciplinary hybrid set of courses devoted to studying adaptation to sea level rise for urban neighborhoods in Norfolk, VA. The existing course set, combines lecture, community engagement, and, most crucially, an active design studio. The course set is taught under the aegis of an established cross-university, cross-disciplinary entity - the Coastal Community Design Collaborative. The overarching objective is to model effective trans-disciplinary collaborative research and design in teaching, learning, and productivity.

Specifically, the research asks: What pedagogic tools, curricular support, and teaching strategies can foster trans-disciplinary collaboration among students from engineering, architecture, and science programs? It seeks to evaluate impacts on students' short- and long-term career interests and it asks: What shifts in focus and methods are required for faculty to effectively lead a trans-disciplinary design studio?

The most closely allied educational paradigm for the NCA's "Cross-cutting Foundational Research Capabilities" is trans-disciplinarity, defined after Nidolescu as work involving knowledge from at least two disciplines, with neither predominant [2]. Stein defines trans-disciplinary inquiry as that in which "individuals demonstrate at least two disciplinary competences, neither of which is primary. They work and contribute to both and generate unique findings, conceptions, and artifacts as result of an emerging trans-disciplinary perspective. They are able to communicate with those from a variety of disciplines in a synoptic manner [3]." Per Dykes et. al. "Disciplines come together to focus on a concept, such as urban intervention. This context brings diverse disciplinary concepts together to explore new questions [4]."

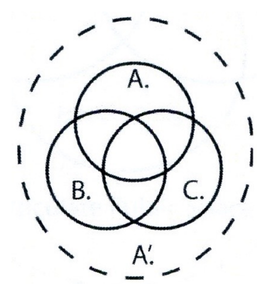

Figure 1. Transdisiplinary design from Dykes et. al.

The STEM program in Adaptation to Sea Level Rise has been generated in an architecture rather than a traditional STEM department in part due to the efficacy of the profession's teaching mechanics in tackling problems of complexity. Studio based learning (SBL) is the center of most design programs; it involves a number of features including a dedicated workspace, the exploration of iterative design solutions to an "ill-defined" problem, extended interface between students and faculty, formal critique involving participation by extra-academic professionals, informal critique ("pin-up" and "desk crit") in which faculty and students seek ways of framing and reframing solutions for questions and problems, and peer participation in design critique. That the iterative design process is analogous to the pursuit of the scientific method has been noted, and as a consequence, it has been successfully imported as a course structure in math [5], [6], biomedical engineering [7], physics [8], computer science [9], and chemistry [10]. The current program involves students of architecture acculturated to studio based learning modes of exploration and productivity, which eases the transition into such a learning environment for students from divergent fields in the sciences and engineering.

Studio based learning engages students in theoretical, practical, interactive, and reflective stages of learning, preparing them for success in future research and professional design engagement. As a bridge between academic and professional worlds, it can provide the initiating sense of legitimately belonging to a profession, a crucial step toward long-term productivity within the profession [11].

The application of the impacts of SBL and of the exploration of developing trans-disciplinary study firmly rooted in a process acknowledging inherent conflicts between methods and models embedded within each participating discipline should provide useful data, insights, and replicable models for programs seeking to improve minority persistence and success in STEM research and professional practice.

In addition to the program's potential to more securely seat under-represented students in their elected professions, the program also should serve to attract and retain more women to this and other STEM programs and careers. In her study of why women of color fail to persist in STEM fields, Espinosa notes a consistency within the study group of "altruistic ambitions…. All women, regardless of race, leave STEM in part because of the inability of professors to make science accessible and aligned with their goals of contributing to society…Pedagogy matters [12]." Crucial paths to learning for women include "aligning theoretical concepts with real-world scientific problems, and increasing interpersonal collaboration [13]." That the study program is focused on a real and urgent problem and is based in collaboration argues well for its utility in increasing success for African American women in STEM. The program, created at an HBCU, has already produced several graduates now pursuing advanced research degrees and positions of leadership in the subject at jobs within their professions. It is a program of great potential in broadening participation of African American undergraduates in STEM-related inquiry and future professional and academic success; if re-tooling it to trans-disciplinary activity succeeds, the potential exists to have its graduates at the forefront of emerging fields of inquiry.

It is argued that the program entitled "Charting a Path to Transdisciplinary Collaborative Design" holds great promise to increase the number of STEM professionals who have trans-disciplinary experience to undertake the challenges of engineering solutions to coastal impacts of climate change.

Context: Adaptation to Sea Level Rise

Globally, sea levels are rising, with the rate of rise and speed projected to increase with each passing year [1]. Its impacts, however, are manifesting at varying rates, putting some communities at the forefront of developing adaptation strategies. Due to several factors - land subsidence, variation in gulf stream speed, and increased volume of precipitation – southeastern Virginia finds its communities, its roadways, and its properties subject to recurrent flooding. Its geographic location makes a strike from increasingly intense storm systems almost inevitable.

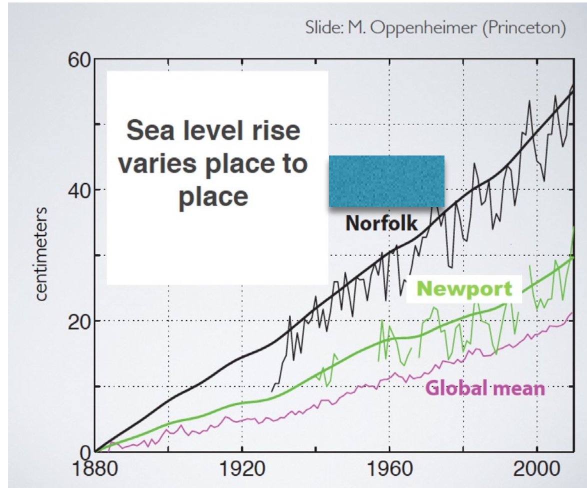

Figure 2. Accelerated impact of sea level rise in subject study area. These impacts and modeled approaches to adaptation and mitigation will be of use to other coastal communities globally as conditions mimic those experienced currently in the study area. Source: Dr. Gabriel Vecchi after Oppenheimer, Princeton University Department of Atmospheric Sciences and Oceanic Sciences, 2.17.17

While the fate of the region may not be rosy in the long term, the urgency of recurrent flooding has created an environment in which cities and academics struggle to plan and to identify strategies to ameliorate the impacts of a changing environment. Immediately apparent is that no single discipline is equipped to provide guidance. Rather, the changing world demands that government agencies, professionals, and academic entities emerge from the silos of their specialties and collaborate in seeking understanding and paths forward. Ultimately, the work done in this first area should prove globally useful as other coastal communities inevitably experience similar challenges in the future. In the meantime, all contributions to exploring solutions to a daunting array of physical and social challenges are welcome.

Context: Overview of existing interdisciplinary program

In 2014, students at the Hampton University Department of Architecture began a project to work with the neighborhood of Chesterfield Heights in Norfolk, VA to study strategies to mitigate current issues related to flooding and sea level rise to prepare for the inevitability of severe storms. Engineering students from Old Dominion University joined the effort, first as volunteers and then as capstone design students.

The project began with significant community engagement which was orchestrated through the civic league. Students were thus able to pin-point flooding, shoreline erosion, and the rates at which basements were taking on water and develop an urgent level of motivation to help community members with whom they became acquainted. Simultaneously, students met with academics and area professionals with expertise in pieces of the puzzle (preservationists, marine biologists, landscape architects, oceanographers, and hydrologists among them) and with city planners and storm water managers. What emerged was a set of precepts concerning design suites of redundant management solutions, each taken through preliminary design and cost estimating to leave the community with an array of options to focus on in successive fiscal years;

overarching commitment was to green rather than gray infrastructure wherever possible, and to leave buildings and people in place as long as may be practicable. The suite of solutions was run through Environmental Protection Agency's (EPA) Storm Water Management Model (SWMM) program and was found to keep the community dry from three feet of sea level rise and through a 100-year storm.

The city of Norfolk adopted the project into an international design event, Dutch Dialogs Virginia. The state submitted it to HUD's National Disaster Resilience Competition, where it was awarded $115,000,000 in implementation funding and is currently under construction. The project and program have attracted national and international attention from media and several learned bodies in disciplines beyond engineering and architecture.

Subsequently, two more neighborhoods and two emerging arts districts have been studied with the same set of goals and precepts. Additionally, during subsequent semesters, the program has been established through a memorandum of understanding between Hampton University and Old Dominion University as the Coastal Community Design Collaborative. An academic concentration in Adaptation to Sea Level Rise has been formalized by Hampton University with its first graduates from Architecture and Marine and Environmental Science in June of 2018; six more students have followed.

The core two semesters of the four-course suite attached to the concentration have developed into a full year program. An introductory course mixes content delivered through lectures on core physical and social sciences for one day each week, with initial design exercises for the second. In the spring semester, all focus is on designing and pricing a suite of solutions for the district under study.

The program has achieved many things. This project will evaluate the program as it is for baseline information and will model interventions to improve functionality and replicability.

Proposed Research Activities and Goals

The pedagogic components and conceptual model are summarized in Figure 3 below:

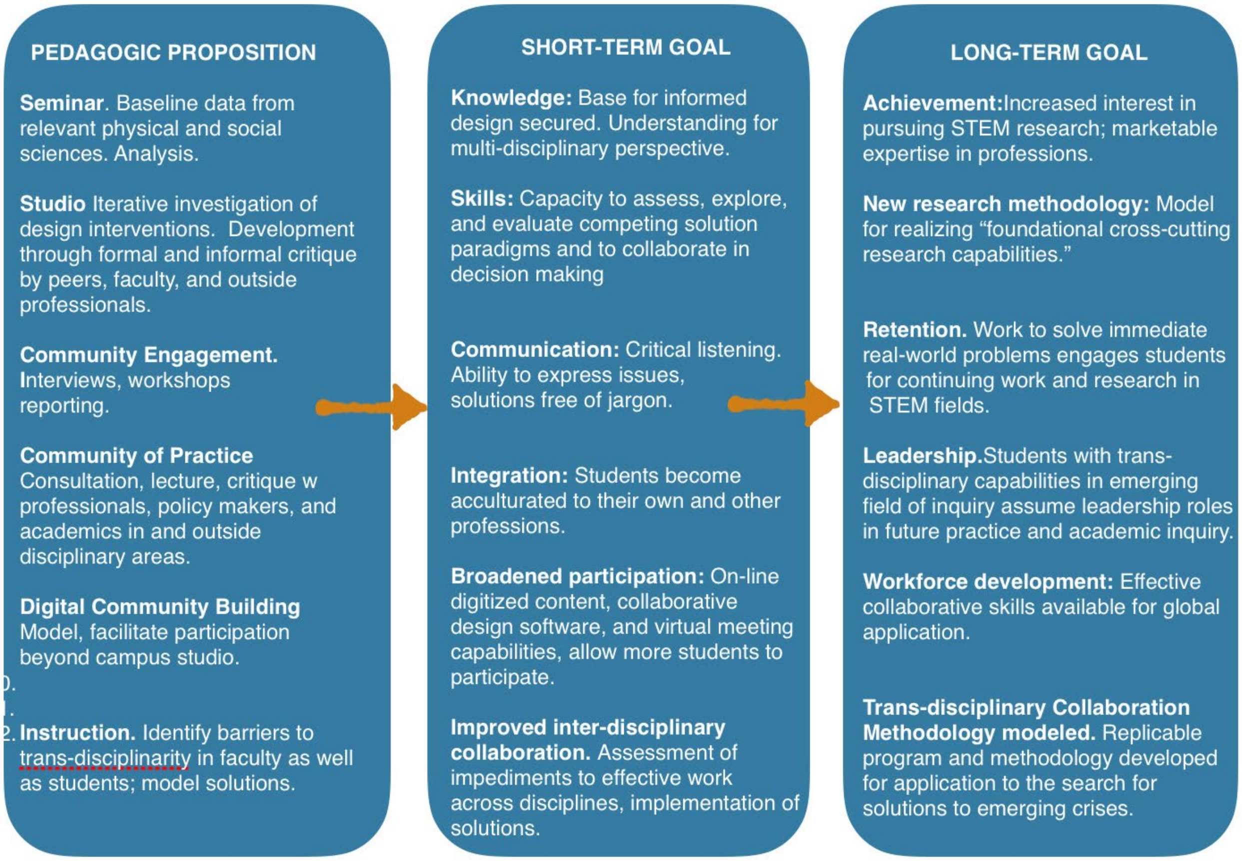

Figure 3. Pedagogic components and conceptual model

Concluding Remarks

With crises such as sea level rise emerging at a scale and speed that require effective input from many disciplines, what may occur is new trans-disciplinary fields. We believe this will be the case and presume modeling effective strategies to work well across disciplines is crucial. Indeed, we may see new disciplines emerge. The National Climate Assessment’s Research Needs section suggests that in the immediate future there is a national need to:

- Strengthen approaches to education about climate, impacts, and responses, including developing and evaluating the best ways to educate in the fields of science (natural and social), technology, engineering, and mathematics and related fields of study (such as business, law, medicine, and other relevant professional disciplines). Ideally such training would include a deeper understanding of the climate system, natural resources, adaptation and energy, policy options, and economic sustainability, and would build capacity at colleges and institutions, including minority institutions….

- Identify increasingly effective approaches to developing a more climate-informed society that understands and can participate in assessments, including alternative media and

methods for communication; this could also include a program to certify climate interpreters to actively assist decision-makers and policymakers to understand and use climate scenarios [1].

The team respectfully submits that there are compelling reasons indeed for initiating this research project.