

Building a Sustainable University-Wide Interdisciplinary Graduate Program to Address Disasters

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Background

Disasters continue to devastate communities across the globe, and recovery efforts require the cooperation and collaboration of experts and community members across disciplines [1-3]. The Disaster Resilience and Risk Management (DRRM) program, funded through the National Science Foundation (NSF) Research Traineeship (NRT), is an interdisciplinary graduate program that brings together faculty and graduate students from across one large, mid-Atlantic university in order to develop novel transdisciplinary approaches to disaster-related issues. The project seeks to improve understanding and support proactive decision-making relative to disaster resilience by establishing a sustainable transdisciplinary graduate education and research program capable of developing the next generation of researchers, educators, and decision makers.

In this paper, we briefly describe the program's goals and current status, then focus on the supports and barriers to helping graduate students develop interdisciplinary professional identities, drawing on frameworks for identity-based motivation to guide our analysis. As we have reported elsewhere [4], annual interviews with program participants suggest that while some students experience substantial interdisciplinary identity development, not all students who join the program want to become interdisciplinary scholars, and even some of those who do seek such development experience multiple institutional and structural barriers. Given the extensive investment in interdisciplinary graduate programs nationally, we argue that a deeper understanding of how and why graduate students do – and perhaps more importantly, do not – develop interdisciplinary identities can help inform future development of interdisciplinary programs.

Current Status of the Educational Program

The original core team includes faculty from business information technology, civil and environmental engineering, engineering education, geosciences, and urban affairs and planning. Now in our fourth year of course offerings, the program has expanded to include faculty and students from fisheries and wildlife, industrial and systems engineering, geography, sociology, building construction, and beyond. The primary educational objectives of the DRRM program are (1) context mastery and community building, (2) transdisciplinary integration and professional development, and (3) transdisciplinary research. The educational research and assessment spans program development, trainee learning and development, programmatic educational research, and institutional transformation.

Our education and training model seeks to develop a transdisciplinary community of practice (CoP) [5] that not only provides participants with disciplinary knowledge and interdisciplinary skills, but also transforms their identity as learners, researchers, and practitioners to enable them to think and work beyond disciplinary boundaries. A CoP is a group engaged in a joint enterprise with a larger set of goals negotiated among participants and shaped by the larger context. In NRT:DRRM, this enterprise focuses on developing models, tools, and strategies to increase

disaster resilience by reducing negative consequences of hazard impacts, as well as the cascading impacts they in combination induce, by actively incorporating stakeholder voices, needs, and perspectives. Community members interact as they pursue that enterprise, reflecting a high degree of interdependence and ongoing interaction. Mutual engagement is particularly important in transdisciplinary work, where individuals from different fields and communities must learn from each other and build new ways of knowing and doing. The shared experience can then be leveraged to strengthen interactions with stakeholders and decision makers to develop, communicate, and implement solutions.

Finally, CoP members share a repertoire of tools, concepts, and language. In this framework, learning occurs as disciplinary novices engage in authentic problem solving with others and build a shared repertoire of skills and perspectives unique to the nature of the problem and the composition of the community. Across the NRT, this process occurs as trainees work with the team of faculty mentors, with one another, and with diverse members of communities affected by potential disasters to model hazard impacts and socioeconomic recovery and to develop proactive strategies that identify specific vulnerabilities. Equally important, CoP treats learning as a process of identity development rather than simply acquisition of knowledge, and the process is bi-directional: even as the community shapes learners, learners bring their histories and identities in ways that redefine the community. The NRT:DRRM program continues to evolve through daily interactions and through ongoing formative assessment that helps refine our approach. Toward these goals, the DRRM program includes a range of educational opportunities:

- A 3-credit course ideally taken at the start of the program to introduce students to the relevant issues and methods. The course is open to graduate students across the university and serves to set the stage for ongoing research dialogue and collaboration.
- A 1-credit seminar course taken each semester for the first two years, but always open to all program participants. The course brings together students across program years to support vertical integration and develop a rich research culture. The course includes speakers from around the university, workshops on communication and collaboration, and opportunities for students to get feedback on work in progress.
- Opportunities to engage with stakeholders beyond the university to help DRRM graduate students build relationships with community, non-profit, and government leaders.
- Ongoing guest speakers, workshops, conferences, and social events beyond the required courses to help build the DRRM program into a community of practice.

The program is now in its fourth year of student enrollment. Core courses on interdisciplinary research methods in disaster resilience are in place, engaging students in both domain specific research related to natural hazards, resilience, and recovery and in methods of interdisciplinary and transdisciplinary collaboration. The team is building capacity in professional development opportunities through collaboration with other units on campus. In particular, the university's Center for Communicating Science has partnered with the team to bring theater techniques into the classroom to help scholars learn to communicate their work to a wider audience, and the program has leveraged the university's land-grant mission to create projects with the state's Extension Service. Unfortunately, the COVID-19 pandemic has limited collaboration with

Extension, but this partnership holds significant promise as a venue to build stakeholder engagement opportunities.

Development of Interdisciplinary Identities

Consistent with situated views of learning broadly [6] and communities of practice in particular [5], our program seeks to not only provide students with skills that support interdisciplinary collaboration, but also to help them develop professional identities that incorporate interdisciplinary work. Theories of identity-based motivation [7] highlight the importance of individuals self-concepts (including hoped-for futures) in determining their present actions. Thus graduate students' perceptions of their current and possible future identities as interdisciplinary scholars can help shape where and how they engage in and learn from graduate programs such as DRRM and others funded by the National Science Foundation's NRT program.

To track the ways in which our program participants are or are not developing such identities, we conduct annual interviews with each student at the end of the spring semester. The first two cohorts of the program have enrolled 26 participants, with 18 from STEM disciplines and 8 from the social sciences. Approximately half the program participants identify as female, and half as male, with none identifying as non-binary. Participants from the first cohort have participated in 3 interviews to date, while participants from the second and third cohorts have participated in 2 interviews and 1 interview, respectively. Note that because of the COVID-19 pandemic, the team shifted to virtual interviews via Zoom, and the pandemic may have limited engagement from some participants in the spring of 2020 and 2021. At each interview, program participants are provided with informed consent information (Virginia Tech IRB #17-599) inviting them to consider allowing the team to use their annual interviews for research purposes. To date, we have completed 44 interviews that include consent. We also do not identify the exact demographics of those who consented to the research as that could also compromise anonymity, but we do note that the profile of the 44 participants who consented to allow use of their interview data for research is representative of the overall population.

Interview are analyzed through systematic qualitative coding each year to identify changes in participants' desire to be interdisciplinary scholars and the extent to which they believe they have developed an interdisciplinary identity. Across the data, the findings indicate that while some students grow in both their desire and their perceived development, others have more complex trajectories, and in fact, not all participants value interdisciplinarity as a goal. Figures 1 illustrate these findings for each cohort of students, where the x-axis represents whether the student considers themselves an interdisciplinary scholar and the y-axis represents whether the student wants to be an interdisciplinary scholar.

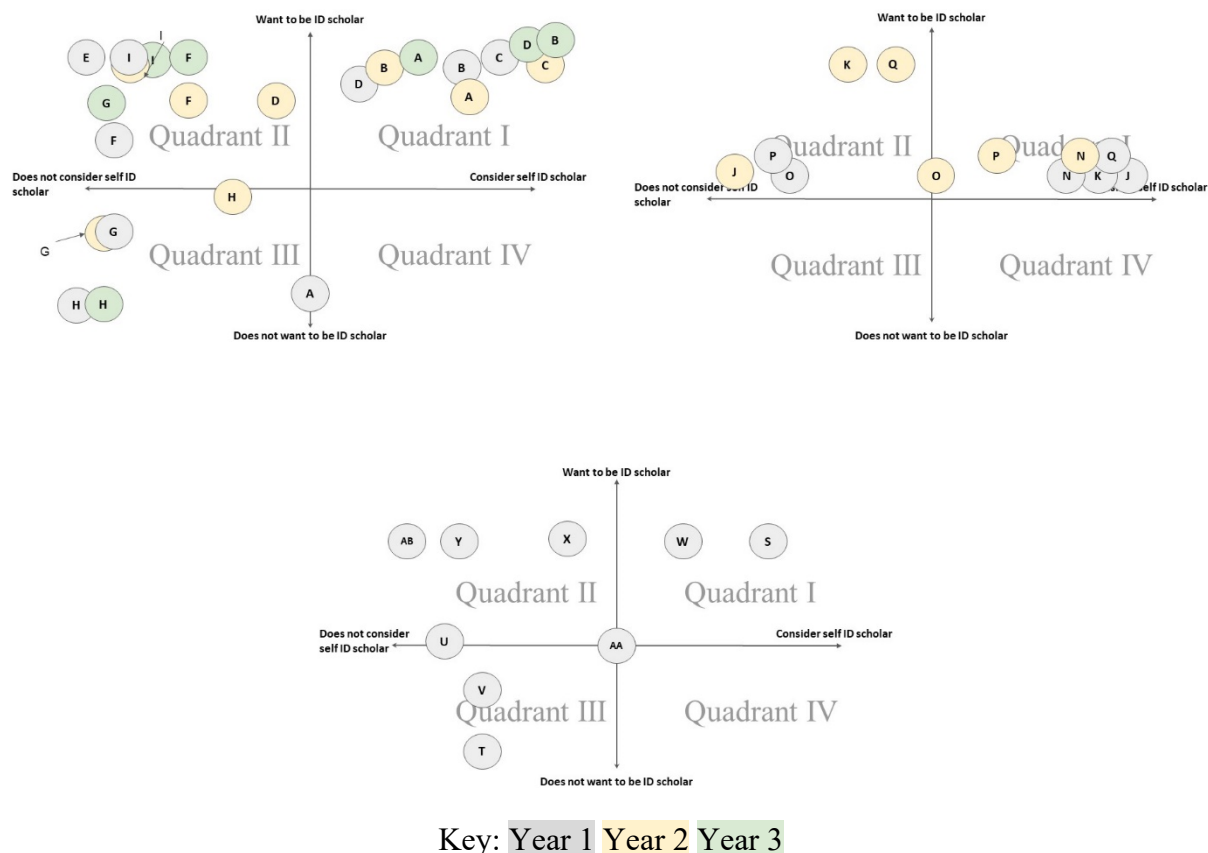


Figure 1: Identity trajectories of program participants

In previous work [4], we used Possible Identities [7] to explore these identity trajectories. Possible identities (based on Markus and Nurius' theory of Future Possible Selves) posits that individuals act in the present to achieve imagined future selves when those futures are congruent with their present sense of self, closely connected (e.g. in time) to their present self, and achievable – that is, that challenges that arise on the path to this future can be managed or overcome. Qualitative analysis of the interview data of a subset of the participants showed significant variation in students' perceptions of connections, congruence, and achievability, as well as participants' overall desire to become an interdisciplinary scholar. Table 2 illustrates this range for interviews from participants in the first two cohorts at the end of their first year:

Table 2: Summary of Participant Codes

Number of Participants	Connection	Congruence	Achievability	Desire to be Interdisciplinary	Interdisciplinary Identity Status
4	Connected	Congruent	Possible	Yes	Attained
7	Connected	Congruent	Possible	Yes	In Progress
1	Connected	Congruent	Possible	Unsure	In Progress
1	Unsure	Incongruent	Unsure	Yes	In Progress

1	Not Connected	Incongruent	Unsure	Unsure	In Progress
1	Not Connected	Incongruent	Unsure	No	Neither

Barriers to Interdisciplinary Identity Development

To explore the variations in individuals' perceptions of their identities, we analyzed the interview data to further using emergent coding practices [8] to explore potential supports and barriers around interdisciplinarity for graduate students in this program. Initial findings comparing two students' experiences over time were presented previously [4]; in this section, we present findings developed from interviews with 23 participants. Salient themes include limited leadership, competing goals and expectations, incentives and interests, and worldview conflict.

Limited Leadership

Limited leadership reflects limitations in faculty availability and program support, reflected in participants' desire for more examples of interdisciplinary scholarship and for more guidance navigating the existing hierarchical structures and processes in the university. Participants noted their role as pioneers in their respective fields due to their niche interests and interdisciplinary approaches. However, several reported not knowing who to turn to for inspiration; one noted that "the kind of research [I am] trying to do is very much different from what my advisor does. This is very new to her, and also to me." Students sometimes had to look beyond their primary advisor, but felt the program needed to provide more visibility of faculty advisors across disciplines. Students perceived that "some of the faculty seem more interested...listen more, and try to give feedback...like a core faculty group," but most were not able to attend meetings regularly and were unaware of students' research interests. Discord existed between students' expectations for their interdisciplinary programs' offerings and the faculty involved in planning. "Uh, the faculty even they don't know who is charge of the seminar [...] So we don't know who's responsible to utilize this one hour in a productive way."

Limitations in available guidance and support could also be more localized when a student's role as an interdisciplinary pioneer conflicted with their advisor's interests and capacity. This phenomenon was evident when one student described that "the support of the professor is very important...and so I can extend my background into inter-discipline. I can go to other disciplines and find the connections and interdependencies. I think by having the support of the advisor... I progress in both aspects (i.e. disciplinary and interdisciplinary)." Without such support, the conflict became more apparent, as another student explained:

I was originally a direct Ph.D. student here at [my university]. And that changed primarily because of me not feeling super comfortable in my department as well as difficulties connecting with my adviser... I can be a researcher that is understood in DRRM when I present my stuff, when I talk about my stuff, everybody is kind of like into it there. They're supportive; they're excited. And then when I do like when I present it to my department, I am definitely notably different. And it's kind of uncomfortable.

Participants were also acutely aware of existing disciplinary silos; breaking outside of those silos required moving against the status quo, and pedagogical structures in certain disciplines were

ubiquitous and seemingly unshakable. These structures, in turn, threatened the ability of students with diverse backgrounds to build interdisciplinary identities, as is evident the following excerpt:

Universities say they want to do interdisciplinary research; like it's the new wave but I don't quite see how they're doing that, or like making the way for that because when I graduate, I was still going to apply to a [discipline] department or an [related discipline] department or something like that...they're not giving what they said they're supposed to, so I don't see it. I feel like it's going to be one of those you say you want it, you didn't quite plan it out well, and inherently continue the cycle of disciplinary silos.

Competing Goals and Expectations

These limitations in leadership reflect related challenges of competing goals and expectations. Students balanced their desire to build interdisciplinary knowledge and capacities with the desire to become an expert in their field, the need to publish, and the pressure to find a job upon graduation. Reflecting on these conflicts, one student explained:

I can try to read some paper, literature, and try to understand that, but I don't think it's worth it, because it's a time cost. I need to focus on my dissertation...and it will not help me find a job in the job market. The most challenging part was finding time to have meetings, to work more on [interdisciplinary] projects. Because, for example ... I had my qualifying exam. And I needed to write my research proposal. [The interdisciplinary project advisor] was also very busy with his courses.

Competing goals and expectations may also emerge from advisor or department expectations in that not all faculty necessarily consider interdisciplinary work feasible or appropriate during graduate school, and program requirements can limit available time. For some students, the interdisciplinary program competed directly with their own goals and expectations for graduate school. Those goals and expectations reflect normative conceptualizations of what the Ph.D. should be, embedded with the cultural and institutionalized values placed on the degree, reflected in comments such as

I don't think that for PhD students we could really go beyond discipline because it's just about finding, it's just about the time limit, it's just about the project goals.

PhD students need to be first author...and everyone is a PhD student so it is hard to collaborate.

We need to become an expert in our discipline first, and then collaborate or work with other disciplines should be the second step.

Incentives and Interests

Given the competing goals and expectations, incentives for and interest in interdisciplinary work also played a key role in identity development. For some students on the cusp of interdisciplinary scholarship, it appeared "easier" to pursue one discipline than to balance multiple and intersecting disciplines. Upon reflecting on interdisciplinary project work, one participant

described feeling “that this is not that much related to my graduation...so, [I have] low motivation. If that project was related to our PhD study...I think we may continue.” When interdisciplinary projects are tangential or in addition to the ways in which advisors and committees scope the dissertation research, students often stayed in their disciplinary silos. Incentives for interdisciplinary work are often in the form of financial support and publications, as well as career experiences geared toward future employment.

Even with tangible incentives, however, student interest plays a key role. Not all students joined the NRT program because of a strong interest in interdisciplinary work; instead, funding was the primary driver, with the “interdisciplinary” component seen as a requirement. One participant noted, for example, “in the first sense, I don’t have interest. I don’t have a passion [for] those things.” Another rejected interdisciplinarity entirely, saying, “I would rather be more purely disciplinary just so I could go back to what brought me to grad school in the first place. And then the interdisciplinary, it’s like a nice side effect of what we’re doing, but it’s not my goal.” Students noted that becoming an expert in a field at the doctoral level requires highly specialized interests, and finding people with similarly minded research topics is difficult. Specialized interests and disciplinary leanings made it more challenging, and for some students less motivating, to mesh their ideas with those of their advisors and to engage in courses from other disciplines that employ alternate pedagogical approaches or address content peripheral to their own goals. Such students craved guidance from like-minded scholars because they saw no clear guidebook for tackling interdisciplinary research questions.

Worldview Conflicts

Finally, conflicts related to worldview – that is, epistemological beliefs about what counts as knowledge and how knowledge is constructed – also posed a significant barrier. Often STEM graduate students, in particular, were unfamiliar with the concept of worldviews, but once the concept is introduced through the program courses, students recognize the palpable contradictions. As one explained:

Coming from my background, I am not, you know, they say that left brain, right brain doesn't exist; but we think so differently and you can pretty much flip a coin with these policy kids or the poli-sci – I'm not going call them soft sciences anymore, because I think it makes people feel uncomfortable.

Competing worldviews also made collaboration challenging. However, multiple participants mentioned benefitting from talking “more about worldviews and having these conversations” because “you don’t have to just rely on these specific worldviews [and can understand] that there’s different forms of understanding knowledge.”

Worldview also influenced students’ perceptions about the ways in which work in the DRRM space is more tightly linked to certain disciplines or that some fields are more essential or harder than others. One noted, for example, “when people think of disasters like natural resources is not the first thing that comes to their mind... you’re going to think of like medical relief and engineers.” Another noted they would prefer “less human science courses and more technical courses.” This student went on to say, “my statistics are not lies. Like this is data. This is- to me this is law, this is mathematical law.” These value differences resulted in challenging work

environments, a lack of emotional support, and discipline-constrained trust. Educated within a specific discipline, students lacked a frame of reference for understanding other disciplinary domains. Further, students were socialized to believe that certain research did and did not belong within a space and that some disciplines are better off without collaboration. Such beliefs could also be reinforced by faculty; as one student noted, “when I present something about disaster in my department, they are always saying that it’s too specific. It’s too specific, and I don’t understand.” The perceived value of disciplines and a lack of open-mindedness leads to damaging disciplinary stereotypes that discredit the work of researchers in different domains.

Program Developments and Next Steps

Participants’ explanations of the barriers to developing interdisciplinary identities during their graduate education point to several important implications for interdisciplinary graduate programs. First, limitations in leadership reflect, in part, the challenges in fully funding and sustaining faculty work in interdisciplinary programs. The NRT program itself provides very limited funding for faculty time, and our home institution also lacks meaningful options for buying out faculty time and ensuring that interdisciplinary work is rewarded in concrete ways. One concrete step toward addressing this barrier has been through our program’s alignment with a newly developed campus center that can provide some funding for faculty time and some incentives for students. However, this alignment with the new center reflects one step, not a systematic institutional solution.

Transformations in institutional culture are also essential to addressing competing goals and expectations, as well as incentives and interests. Even when faculty advisors are engaged in and/or supportive of interdisciplinary work, students are also accountable to committees, departmental expectations, and desired future jobs that may not yet align with interdisciplinary values. Work thus remains not only within our program, but institutionally and nationally to reframe the conversation around interdisciplinary graduate education. Moreover, competition for funding can incentivize students and advisors to participate in funded interdisciplinary programs even when such programs may not fully align with individual goals. Screening of participants can help mitigate such issues, but the broader nature of funding for graduate education in the U.S. plays a significant contextual role here that must be considered. As our program transitions from NSF funding to localized institutional support, the role of fellowship funding will diminish, but that may also pose challenges for recruitment and engagement. Again, our alignment with a new university center mitigates, but does not eliminate this challenge.

Finally, questions of worldview are ones that the DRRM education program is directly addressing, with additional time and energy being invested annually in developing models of interdisciplinary pedagogy that both respect student time and engage them in meaningful boundary-crossing work.

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