

## Personal Statement by Leesha V. Maliakal

Independent research experiences provide numerous personal, professional, and societal benefits including enhancing student learning, and broadening student participation and retention in diverse fields of study. Quality mentoring, sustained training, and practicing core modes of thinking in the discipline are crucial factors that support student intellectual growth and interest in science and research careers. However, our ability to scale these rich learning opportunities to more students is limited by the practical orchestration challenges around getting students the support they need to train as researchers given limited mentor resources. In my graduate work, I aim to design, implement, and evaluate novel *orchestration technologies* capable of detecting diverse student needs, recognizing and identifying available actions and help resources to meet those needs, and connecting resources and needs in ways that are cognizant of the collective needs and resources across a community.

Throughout my academic career at Northwestern University, I discovered that I loved supporting others through their learning processes. I have given back to the community by supporting those around me through my research and extracurriculars. For over two years, I volunteered with Brave Initiatives, a Chicago based weeklong camp that empowers high school girls to be agents of change in the world through design thinking, programming skill development, and leadership training. I developed the coding curriculum, designed and taught coding modules, and mentored these young women. Three of my mentees are now pursuing technical degrees. As a part of extending the broader impacts of my recent research, I designed the Agile Research University program, a free program for faculty to visit our research studio and observe and learn how to adopt our Agile Research Studios model to scale undergraduate research training. Five HCI faculty are already adopting the model in their own research practice.

I've actively pursued teaching and mentorship opportunities as a way to support novice designers and researchers as well. As part of my summer research, I conducted the instructional design of an iterative design learning environment. This involved deconstructing expert practice in iterative design into a curriculum that I taught to novice designers. As a part of my graduate training, I mentor undergraduate researchers in the Design, Technology, Research (DTR) program that I co-designed with my advisor Haoqi Zhang. I have helped mentor three research projects and four students, two of which have just submitted their first paper to CHI 2017.

However, I faced many difficulties in getting the support I needed to succeed academically. The road to these successes was especially challenging for me. As a young woman starting her Computer Science degree at Northwestern, I struggled to keep up with my learning. I developed this mindset of "I can't ask for help if I don't know what I'm talking about, so I need to keep working on my own, and work harder until I get it right." I didn't think to reach out for help and utilize the resources around me, partly because I didn't know what to ask for, and my grades suffered as a result. I hadn't yet figured out how to leverage support to learn effectively.

I overcame this tremendous adversity by developing the *regulation skills* - cognitive, motivational, emotional, metacognitive, and strategic behaviors for achieving a goal - required to excel as an academic through the Design, Technology, Research (DTR) community. When I first joined the program, we were a group of 8 undergraduate researchers. Since then we've scaled to 2 P.I.s, 5 doctoral students, and 20+ undergraduates working on independent research. It was in this growing and supportive community that I began my development as a researcher.

I began my research with a crowdsourcing project called CrowdCheer, where I first explored how computational systems could be used to scale and provide continual support.

CrowdCheer is a system that uses a *continual support architecture* to monitor a user's experience and provide continuous support as needed by coordinating the detection of needs and help resources and connecting those helpers to those who need help in real-time. To study this system, I've been looking at marathon races and studying how a crowd of spectators might provide distributed motivational support for runners. Solving these challenges allows us to now think about providing on-demand support to overcome barriers as they arise. In order to provide this on-demand support, we need systems and architectures that recognize existing crowds as support resources, and identify support opportunities and respond to them as they occur.

By working on the CrowdCheer project for over 3 years, I developed the regulation skills in planning, help-seeking, and reflection that supported my working through the challenges of working on highly-ill structured problems like those presented in design-based research. These skills enabled me to more effectively develop my design, technical, and research skills. For example, I gained human-centered design skills in brainstorming, feedback, interaction design, needfinding, prototype testing, and UI/UX design. I developed the technical skills needed for constructing complex computational systems, such as algorithm and system architecture design, mobile and web development, pair programming, and debugging skills. I developed the research skills - grant writing, literature reviews, research direction, study design, data analysis, manuscript writing - which helped me identify my research contributions and present them to the research community. I presented my work on CrowdCheer at the Grace Hopper ACM Student Research Competition, where I was **awarded second place out of 117 participants** from across disciplines in Computer Science, and I am currently preparing a manuscript for a full paper submission later this year.

I became curious about the theoretical underpinnings for how the DTR research community could so effectively support my development as an academic. I decided to pursue a Ph.D. in the Technology and Social Behavior program where I could work with Haoqi to design communities that could support these rich learning experiences. Through our research, I realized that this type self-directed learning could not easily happen without a great deal of support in developing these skills. I also realized that this level of support could not easily have happened without a technology-enabled learning community. We asked, how might socio-technical systems train large numbers of students to conduct authentic research and produce research outcomes without increasing the orchestration burden on research mentors? We proposed the *Agile Research Studios (ARS) model*, a socio-technical system for scaling research training that integrates effective work processes, social structures, and technologies to create sustainable research communities of practice by adapting agile methodologies to research training and making effective use of the expertise and resources across the community to respond to needs and support progress making. Our work led to a full paper publication at Computer-Supported Cooperative Work and Social Computing (CSCW 2017). We've since trained over 50 students (mostly undergraduates) in independent research. Collectively, we've won 4 student research competition awards, 29 research grants, and published 11 papers and extended abstracts. We now run the ARS University Program where we help faculty jump start their own studios.

I recognized opportunities to leverage the continual support approach we explored in CrowdCheer to further scale models such as ARS. To do this, I needed to have a deeper understanding of the challenges facing learners as they are conduct design/research work and how to measure their performance and learning to evaluate whether a continual support approach could also support learners. I pursued a research rotation with Matt Easterday, where I could

develop the Learning Sciences domain knowledge required to deeply understand how to better design and evaluate learning environments. During that time, I collaborated on two design-based research projects, where we designed, deployed, and evaluated interventions for novice designers learning iterative design. The first intervention was an *iterative design learning environment*, consisting of a design canvas, an iteration plan, and instructional design that helped students represent their design problem, identify their most critical risks, and plan an iteration based on the risks identified. The second intervention, which I led, was an *assessment method for iterative design learning environments*, which builds an understanding of (1) the expert and novice models for iterative design, (2) a process of assessment, and (3) a method of constructing expert models, novice models, and assessment criteria. I also co-designed the next study, defining what iterative design skills are critical to success and how to measure learning. This upcoming work will move the needle on learning measures in project-based learning environments. My work will lead to 2 full papers and a journal article to be submitted to the International Society of the Learning Sciences (ICLS) this Fall. Throughout this work, I deepened my thought processes around what makes for a strong research contribution, practical contribution, how to evaluate those contributions, present evidence for the contributions, and argue for the mechanisms by which they worked in the Learning Sciences domain. This knowledge will enable me to design and evaluate the impact of learning communities like ARS.

Over the past three years, I've developed strong connections to the tight, collaborative, and interdisciplinary community of researchers in the Delta Lab and the HCI community more broadly, who work precisely at the intersection of my research interests. Being part of the Delta Lab has given me access to Learning Sciences collaborators like Matt Easterday and Eleanor O'Rourke, Design collaborators like Elizabeth Gerber, and HCI collaborators like Darren Gergle. I've leveraged these opportunities to practice research in and across these other domains in a way that has prepared me with the integrated skills required to pursue my graduate research.

In many ways, my personal narrative has become my research story. I am deeply passionate and curious about expanding the capacity of learning communities to support the needs of learners at scale. I have developed the design, technical, research, and regulation skills required to succeed as an academic researcher. I have sought out research practice and theory that has advanced my understanding of scaling research training, designing and evaluating learning environments, and orchestration challenges in computer-supported cooperative work. I have developed deep-rooted connections to an interdisciplinary, collaborative, and supportive community that will continue to foster my development as a multidisciplinary scholar.

Through these experiences, I have developed and integrated the diverse set of skills that prepare me to pursue my graduate research through the National Science Foundation's Graduate Research Fellowship Program. I plan to design, implement, and evaluate *orchestration technologies* capable of detecting diverse student needs, recognizing and identifying available actions and help resources to meet those needs, and connecting resources and needs in ways that are cognizant of the collective knowledge, awareness, expertise, and availability across a community. By using mixed-initiative systems to orchestrate continual support across a community, we can leverage the capabilities of humans and machines to change the ways in which organizations work and significantly increase the quality and scale of research training. With these systems, I hope that more students can develop research skills with and within research communities as I did, and continue to fill a critical need for a future workforce that is capable of solving these complex, ill-structured challenges of today.