I started at Michigan State as an assistant professor in August of 2014 with a joint appoint in the Lyman Briggs College (75%) and the Department of Physics and Astronomy (25%). As a physics education researcher my teaching and scholarship are strongly intertwined. My research directs the teaching decisions I make and my teaching in turns informs my research. The guiding principles for my career focus on understanding how to make the discipline of physics a more inclusive place for a diverse group of students. My research focuses on mechanisms for impacting how (and which) students see themselves as capable of doing physics. In my teaching, I have designed and implemented a classroom where non-physics majors see physics as welcoming and relevant to them. My work on diversity and inclusion in both teaching and research match well locally with the culture of Lyman Briggs and the broader mission of Michigan State University, as well as nationally with recent developments and interests in physics as a discipline.

RESEARCH

As co-director of the Physics Education Research Lab here on Michigan State's campus, I mentor three post-doctoral researchers, advise two PhD students, and have employed a host of undergraduate science majors in early research experiences (between 3-5 each semester). My research focuses on developing the theoretical construct of a *relationship of a discipline*, which is a construct that explains the role that emotions, identity, and beliefs play in predicting the kind of practices a student will engage in within a discipline. My work involves a series of experimental investigations that fit into two different research threads. When combined, these threads help to describe the process by which physics can become a more inclusive place.

Arena 1: Identity, Self-efficacy, and Mindset. Physics is typically seen as a field where only "smart people" with innate ability can excel. This belief makes it difficult for students to see themselves as capable (self-efficacy) or as belonging (identity) in physics. Since arriving at Michigan State I have expanded my research from independently examining how diverse groups of students judge their self-efficacy, to exploring how these beliefs intersect with each other. My work includes understanding how a student's mindset about physics (whether see their intelligence as an innate ability or something that can grow and develop) influencing their sense of ability and belonging.

My current reseach team in this arena includes a post-doctoral scholar, a graduate student in physics, and three undergraduate science majors. Our team has used qualitative tools to expand the way that mindset is typically studied (through a set of pre/post quantitative surveys). Our work has developed a novel methodology for examining mindset in the context of science classroom learning that reshapes how the physics educators think about who is "good at" physics. We have begun to identify the variations in learning experiences that influence whether a student will consider a challenge something they just have to be "innately" good at, or whether it is something they can develop their ability to excel in. Our early results suggest that students use information from 1) their peers; 2) the grading norms in a class; 3) their interest in the subject; and 4) outside of class cultural norms to evaluate whether a particular challenge in physics is something they need so-called "natural ability" to overcome.

In this research arena my team, in collaboration with the College of Natural Sciences, has just won an National Science Foundation S-STEM grant ($4.9M; with a research component of

$780k) to study how students who transfer from a local two-year college to Michigan State University face challenges along the degree path, develop a sense of capability in the sciences, and come to see themselves as "science people." In this work we will be using the methodologies my team has developed to study self-efficacy and mindset in qualitative data from naturalistic classroom settings.

Arena 2: Leveraging an affinity with biology to impact students' relationship with physics. Over the past three years, I have developed a project that investigates the way an interest in biology can be used to develop a more positive relationship with physics. This work begins from the axiom that the largest body of students taking introductory physics courses are life science majors, and that many of these students regard physics as a roadblock that they have to get past rather than something they are interested in learning more about. In my work, I have explored the ways that a physics course can be designed to leverage students' interest in the life sciences in order to help them learn about and see value in physics.

This work draws from a set of case studies where I followed life science major undergraduate students through their introductory physics course experience. I have probed the ways that physics tasks can be designed to include authentic biology questions and the related impact on student success. The results of this work (Phys Rev PER, 2016) include principles for designing authentic tasks, expanding the way we position life science majors in physics classes to build upon their expertise in biology, and encouraging physics instructors to reconsider how they position physics and biology in relation to each other. My current research team in this arena consists of two collaborating faculty, two postdoctoral scholars, three graduate students, and three undergraduate science majors. I have been active in pursuing external funding in this arena (9 NSF proposals submitted), and have served as the PI of an internally funded LPF-CMP2 grant over the last two years. My research continues to expand upon this work, particularly in designing an interdisciplinary assessment to evaluate how these courses support students in building mechanistic explanations of complex phenomena and is directly related to my teaching in Lyman Briggs College.

TEACHING

Althought I have taught a variety of courses while at Michigan State (from Introductory Physics with Calculus in the Lyman Briggs College, to a senior seminar on Gender in the Physical Sciences, to a graduate level course on an Introduction to Physics Education Research), my primary focus has been on the Introductory Physics with Calculus course in Lyman Briggs. This course is dominated by life science majors, and in the recent history of LBCthe course has shifted its content to try and better connect with these majors. A large part of my teaching work in the past three years has focused on redesigning this classroom informed by results from my research describe above in *Arena 2*.

Redesigning LBC Introductory Physics. I was given an impressive opportunity as a pre-tenure faculty member to spearhead LBC's efforts to completely redesign the LB273/274 Introductory Physics with Calculus sequence. This redesign integrated the laboratory and lecture course into a single class, which in turn, involved designing a new classroom space, proposing new staffing plans, and completely changing the content and pedagogy of the course.

I taught this course in its large-lecture format in FS14 and mentored a post-doctoral scholar in teaching it in FS15 (while I was partially on parental leave), before changing to a studio model in FS16. Traditionally these courses have focused on material that is closely applicable to engineering - concepts centered on examples of inclined planes, extended bodies that rotate around different points, and building complicated circuits. Better aligning with the interests of life science majors required including "big ideas" from the other science disciplines: emphasizing the physics in diffusion, free energy, and fluorescence.

In addition to rethinking the content of this introductory physics course, the physics faculty decided to transform the course into an integrated laboratory-lecture (studio) format. This major change required the design of new classroom space as well as a new curriculum. As a physics education researcher, I drew heavily on my knowledge of other successful classroom innovations and my own research. In particular the University Modeling Instruction (on which I did my graduate work) and the NEXUS/Physics curricula (where I did my post-doctoral work) to emphasize the modeling process and the connections between physics and biology in the content.

The primary goal in the design of the new Lyman Briggs Introductory Physics curriculum was to coherently bridge these two curricula into the new Briggs Life Science Studio (BLiSS) Physics course. The new materials emphasize designing experiments and creating models while also making connections to the life sciences. To do so effectively, the materials integrate computational labs that help students tackle the complexity of biology while using simple physics tools. The two semesters of this course redesign have run for one full year in Lyman Briggs and Physics and Astronomy. I have taught two sections of LB273 (both in FS16) and one section of LB274 (SS17). In leading this redesign for LBC, I also collaborated with a biophysicist, [redacted] in the Physics and Astronomy Department in CNS. The result was that the materials I led the development of in the LBC also were used in the new course in Physics and Astronomy - PHY241/242.

In implementing these major course transformations, we also spent a lot of time actively incorporating inclusive teaching strategies. For example, I spend a significant amount of time making a personal connection with every student in my classroom and create groups that emphasize a variety of strengths. I also structure the class to give students multiples ways of being successful. On a midterm exam, for example, I will include analytic problems, experimental design problems, and a practical portion where students conduct some experimental process. In the classroom I also give students credit for participation in the learning activities -- each week they complete a homework activity that extends from the in-class work as well as receiving credit for tweeting a whiteboard showing solutions to in-class problems.

Integrating My Research into My Teaching. The other two courses that I have taught in my first three years at Michigan State include a senior seminar in Lyman Briggs (SP15) and a graduate level seminar course in Physics and Astronomy (SP15). These two seminar courses directly drew from my own research in the content and design of the courses. The senior seminar course was titled, "Gender in the Physical Sciences," and used an activity and discussion format. Concurrent with teaching this course I co-edited a focused collection on *Gender in Physics* for the premier journal in my field (Phys Rev PER, 2016). The content of this course drew from my own work on the gendered culture of physics and I extended the course content to include chemistry, and the computer sciences. My primary goal in this course was to have undergraduate students, who were about to graduate and continue in science fields, to be aware of and consider the biases and cultural expectations about gender in the sciences. In this class, we did activities that included examining our reactions to images of a black female physics instructor, evaluating resumes for a scientific job for evidence of bias, and completing an interview study with successful scientists about bias they have experienced in their own careers.

The graduate seminar I taught in Physics and Astronomy (SP16) was an "Introduction to Physics Education Research." It was a discussion based class that was open to all graduate students and senior undergraduates in Physics and Astronomy; those enrolled included students from a wide variety of fields in physics. I structured this course to give students an overview of the field of Physics Education Research, answering questions about why this research in this field is best completed by physicists, what we know about how to support diverse student groups in physics, and open questions in the field. The course culminated in each student completing a small teaching-as-research project that they wrote a paper on and presented to the class.

SERVICE

I view my service responsibilities both at Michigan State University and in the larger Physics Education Research community as a stewardship of my local and national physics communities to support a more inclusive environment for a variety of students. My service has included codirector our local Physics Education Research Lab (PERL), running workshops both nationally and locally, serving on the leadership organizations of my research field, and serving on committees in the local university system.

I have performed a significant amount of service to my national physics education community, indeed, I receive more requests for service to my professional than I can fulfill. My service enables me to influence the trajectory of my national community and to help develop community norms that align with my values. For example, in the past three years I have taken on leadership roles in the primary professional organizations for physics education: serving as vice-chair and chair of the Committee on Research in Physics Education for the American Association of Physics Teachers, serving on the Statistics Advisory Committee for the American Institute of Physics , and on the Committee on Education for the American Physical Society. I also have recently become an elected member of the Physics Education Research Leadership Organizing Council (PERLOC), the governing body of the field, which is a three year service term.

In addition to these formal service roles in the wider physics education community, I have developed and run an "Introduction to Developing Racial Competency in Physics Education" workshop. I ran this workshop in the Physics and Astronomy department here at MSU, and at 3 national conferences (two meetings of the American Association of Physics Teachers, and one meeting of the American Physical Society National Mentoring Conference).

Locally, I have served for several semesters (FS14, SP15, FS16) as the senior member of the physics group in Lyman Briggs while [redacted] was on leave. In this capacity, I was largely responsible for making decisions about the transformation for the Introductory Physics sequence in Lyman Briggs (see Teaching), and have served on two search committees for the physics group (for a failed search for an Academic Specialist split with the Mathematics group, and for the tenure-track search for the Lyman Briggs/Physics and Astronomy joint position). In the past year, this burden has lightened as [redacted] returned from a leave of absence and [redacted] joined the team, thus sharing the service load in the LBC physics group.

In addition to my service work in Lyman Briggs, I continue to commit a portion of my time to the Physics & Astronomy department. This service work is an important component of integrating myself into the department, particularly as I have no teaching responsibilities there pre-tenure. As co-director of PERL I have organized the Physics Education Research departmental seminar, serve on the committees of an additional three graduate students, and lead the PERL research meeting. As a faculty member in Physics and Astronomy with expertise in teaching and learning, I have welcomed regular meetings with [redacted] concerning her course redesign for PHY241/242 (see Teaching), supported the restructuring of graduate TA training, and have been serving on the Undergraduate Program Committee for the past three years. My primary role in the Physics and Astronomy department has been to serve as a consultant and provide expertise on what exists in the physics education research.

Finally, I have been working to choose opportunities to engage in outreach initiatives with the broader community in ways that feel authentic to me. I have co-led a session for "Grandparent's University" for two years (US15, US16) with [redacted] and this past year I took over this session as the primary instructor (US17).

CONCLUSION

Issues of inclusion and bridging the gap between physics and biology are central parts of my teaching and research portfolios. As I look to the future, I plan to expand my research into understanding the pathways of students who transfer from a two-year-college to a four-year institution to pursue a bachelor's degree in science. These students typically have some of the highest failure rates for completing a science degree in the country. At Michigan State, transfer students who enter into the College of Natural Science largely enter the Human Biology Major with the plan of continuing to medical school. My work understanding the identity and sense of competency development at the interface of biology and physics is an ideal starting place for exploring the pathway for these students. Additionally, I will continue developing materials for the Briggs Life Science Studio (BliSS) Physics course with the addition of laboratory investigations at the cellular level and further development of computational labs. I am excited to continue growing my national and international reputation as a scholar and teacher in physics education, as well as influence the teaching and learning of physics well beyond the walls of MSU.