International Journal of Doctoral Studies

An Official Publication of the Informing Science Institute
InformingScience.org

IJDS.org

Volume 15, 2020

PLUGGING IN: HOW ONE GRADUATE PROGRAM SHAPED DOCTORAL STUDENTS' SCHOLARLY IDENTITIES AS INTERDISCIPLINARY SCIENTISTS

Dawn Culpepper*	University of Maryland, College Park, MD, USA	dkculpep@umd.edu
KerryAnn O'Meara	University of Maryland, College Park, MD, USA	komeara@umd.edu
Amy Ramirez	University of Maryland, College Park, MD, USA	aramire1@terpmail.umd.edu

* Corresponding author

ABSTRACT

Aim/Purpose	The purpose of this paper is to understand how one graduate program shaped doctoral students' scholarly identities as interdisciplinary scientists.
Background	Scholarly identity refers to the ways individuals see themselves as legitimate, contributing members of their academic community. However, much of the research on scholarly identity focuses on students and faculty within traditional, discipline-bound contexts. We therefore know little about how doctoral students develop scholarly identities that are interdisciplinary in nature. By interdisciplinary, we refer broadly to scholarly work that uses methods, concepts, frameworks, or perspectives from two or more academic fields or disciplines, or scholarly work aimed at addressing research problems that spans multiple academic fields or disciplines.
Methodology	This qualitative, ethnographic case study focuses on the University of Maryland's Language Science Center (LSC), which houses a National Science Foundation Research Traineeship (NRT) Program for doctoral students in the interdisciplinary language sciences, which includes fields such as linguistics, hearing and speech, computer science, and neuroscience. The LSC is nationally and internationally known for its interdisciplinary graduate training program and thus provides a platform for understanding the components of graduate training that contribute to students' scholarly identity development

Accepting Editor Erik Shefsky | Received: February 10, 2019 | Revised: November 23, 2019 | Accepted: December 17, 2019.
Cite as: Culpepper, D., O'Meara, K., & Ramirez, A. (2020). Plugging in: How one graduate program shaped doctoral students' scholarly identities as interdisciplinary scientists. *International Journal of Doctoral Studies, 15,* 1-28. https://doi.org/10.28945/4474

	as interdisciplinary scientists. We draw from four years of qualitative data collection, including student interviews, student and faculty focus groups, ethnographic observations, and document analysis.
Contribution	Across the public and private sectors, there is a strong push for developing interdisciplinary solutions to society's problems. However, many colleges and universities are not organized to encourage interdisciplinary collaboration and research. Focusing on the ways one graduate program facilitated interdisciplinary scholarly identity development for doctoral students therefore provides graduate programs with a potential roadmap for navigating the barriers that may block the development of students with interdisciplinary research interests.
Findings	We found curricular and co-curricular NRT program activities contributed to students' scholarly identity development as interdisciplinary scientists by connecting them (or "plugging them in") to a pre-existing, interdisciplinary network of students and faculty; increasing doctoral student competence in the methods, cultures, and perspectives of other disciplines; encouraging doctoral students to find common ground with scholars from different disciplinary backgrounds; and broadening doctoral students' views of the potential impact and application of their work.
Recommendations for Practitioners	Graduate training programs in the interdisciplinary sciences should think strategically about the kinds of activities that help students develop a scholarly identity and the conditions and contexts in which scholarly identity development might be undermined. We offer multiple examples of the kinds of activities graduate programs can consider using to facilitate scholarly identity development and the underlying mechanisms that make such activities successful.
Recommendation for Researchers	Developing a scholarly identity is an important component of doctoral student success and should be considered as a useful potential theory for individuals who study graduate education.
Impact on Society	Graduate programs play a critical role in training not only the next generation of faculty, but also the next generation of scientists in government and industry. If more graduate programs can successfully train doctoral students to be interdisciplinary scientists, societal benefits could include more responsive and adaptive solutions to pressing social problems.
Future Research	Future researchers should consider how different graduate training elements produce students with different types of interdisciplinary scholarly identities, how the scholarly identity of students trained in interdisciplinary graduate programs continues to evolve as they transition into both academic and non-academic careers, and the strategies and experiences of faculty members who mentor students from outside of their own disciplines.

Keywords graduate education, scholarly identity, interdisciplinary research

INTRODUCTION

Over the last 30 years, new research fields such as bioengineering and neuroscience have proliferated at the intersection of disciplines once thought to be rigidly separated. Advocates argue interdisciplinary perspectives are critical for addressing complex problems in an interconnected global society (National Academy of Science, Engineering, and Medicine, 2018; National Science Foundation, n.d.).

Moreover, exposure to interdisciplinary research may make STEM careers more attractive to undergraduate and graduate students by orienting scientific research towards societal problems (National Academy of Science, Engineering, and Medicine, 2018). Thus, enhancing interdisciplinarity may also act as a lever by which to fulfill American workforce needs in science and technology fields (National Academy of Science, Engineering, and Medicine, 2018). Despite consensus on the need for and benefits of interdisciplinary research, there is little agreement on what interdisciplinary research is, how it should be conducted, and the skills researchers need to do it (Klaassen, 2018; Lattuca, 2001, 2003; Lindvig, 2018; Lindvig & Hillersdal, 2019; MacLeod & Nagatsu, 2018; Müller & Kaltenbrunner, 2019). This disagreement presents challenges for higher education institutions seeking to train doctoral students to conduct research that crosses disciplinary boundaries (Boden, Borrego, Newswander, 2011; Borrego & Newswander, 2010; Carr, Loucks, & Blöschl, 2018).

Recognizing the discrepancy between the needs of the scientific workforce and graduate training, the National Science Foundation and the National Institutes of Health created numerous institutional grants dedicated to training and educating interdisciplinary researchers (IGERT, 2011; National Academy of Science, Engineering, and Medicine, 2018; National Science Foundation, n.d.). In particular, the National Science Foundation launched the Integrative Graduate Education and Research Traineeship Program (IGERT) and its successor, the NSF Research Traineeship (NRT) program, to encourage institutions to develop and implement transformative science, technology, engineering, and math (STEM) graduate education programs that prepare students to do research in multiple sectors (National Science Foundation, n.d.).

From these programs, we know there are some practices institutions can use to facilitate student success in interdisciplinary graduate training (Gamse, Espinosa, & Roy, 2013; Gardner, Janusujwicz, Hutchins, Cline, & Levesque, 2012, 2014; Gardner, Szostak, & Repko, 2011; Holley, 2015). However, we know relatively little about the extent such graduate training programs influence the ways students view their own identities as scholars. There is evidence (e.g., Carr et al., 2018; Gantogtokh & Quinlan, 2017; Gardner et al., 2012, 2014; Lindvig, 2018; Robinson, 2016) that conditions in many graduate programs and research institutions are not conducive to facilitating the scholarly identity development of interdisciplinary scientists. Students who fail to develop or receive recognition for their scholarly identities are at greater risk for leaving their programs or their field altogether (Baker & Pifer, 2011, 2014; Carlone & Johnson, 2007; Hudson et al., 2018; Lyall, 2019; McAlpine, Amundsen, & Turner, 2014). Understanding how graduate students develop scholarly identities as interdisciplinary scientists is therefore important to furthering progress towards increased interdisciplinarity in research that occurs inside and outside of higher education. Further, it is important to focus on the ways existing graduate programs navigate some of the known barriers to interdisciplinary training as an example for improvement and innovation.

In this case study, we explore how one nationally and internationally recognized interdisciplinary graduate education program at the University of Maryland shaped doctoral students' scholarly identities as interdisciplinary scientists. By interdisciplinary, we refer broadly to scholarly work that uses methods, concepts, frameworks, or perspectives from two or more academic fields or disciplines, or scholarly work aimed at addressing research problems that spans multiple academic fields or disciplines (Gantogtokh & Quinlan, 2017; Gardner et al., 2012, 2014; Klaassen, 2018). For instance, computational linguistics makes use of computer science methods to understand natural language research problems. We focus on this case as a means for understanding what elements of the program contributed to scholarly identity development. The following question guided our study: How did one graduate training program in the language sciences shape doctoral students' scholarly identities as interdisciplinary scientists?

In the subsequent sections, we review the literature that guided this study, including theories of scholarly identity development, and the ways existing institutional structures, policies, norms, and values might impede students from developing scholarly identities as interdisciplinary scientists. Next,

we discuss our methods and findings. Last, we consider how this study contributes to the literature on interdisciplinary graduate education and scholarly identity development.

GUIDING LITERATURE

Studies on interdisciplinarity in higher education and graduate student development guide this study. In particular, we discuss how structural and cultural features of higher education can undermine interdisciplinary research. Then, we consider the impact of these barriers on the development of doctoral students with interdisciplinary research interests.

INTERDISCIPLINARITY IN HIGHER EDUCATION

Across scientific fields, many efforts to promote interdisciplinary work have produced important new insights on some of the most important challenges of our time. For example, in the arena of health, large teams of researchers from such biological sciences, epidemiology, and social sciences have contributed to the literature regarding HIV/AIDS, aging, and mental health and human development (Rowe, 2008). Environmental sciences and engineering have also assembled expertise from a variety of disciplines to address critical challenges related to climate change and technological development (Brister, 2016; Klaassen, 2018; MacLeod & Nagatsu, 2018).

Despite the advocacy for interdisciplinary scholarship from prominent scientific organizations (National Academy of Science, Engineering, and Medicine, 2018), significant barriers remain to the institutionalization of interdisciplinary endeavors. Colleges and universities are structurally organized around academic departments that represent disciplines (Holley, 2009; Lindvig & Hillersdal, 2019; Lyall, 2019). Creating and sustaining interdisciplinary units requires organizational strategies such as changing tenure and promotion policies (Holley, 2009; Hurtado & Sharkness, 2008; Lyall, 2019; Müller & Kaltenbrunner, 2019), creating shared physical spaces (Borrego, Boden, & Newswander, 2014; Gantogtokh & Quinlan, 2017; Holley, 2015), and dedicating resources and staffing to interdisciplinary program management (Gantogtokh & Quinlan, 2017). Likewise, cultural barriers, such as norms regarding appropriate research questions, methods, theories, and frameworks through which new knowledge is produced (Brister, 2016; Holley, 2009; Lyall, 2019), also thwart scholars from doing interdisciplinary research. For instance, numerous studies highlight that interdisciplinary scholars face challenges to their legitimacy from their more traditional disciplinary colleagues (Gonzales & Rincones, 2012; Holley, 2009; Hurtado & Sharkness, 2008; Lyall, 2019).

GRADUATE STUDENT DEVELOPMENT

Higher education's organization by discipline has implications for graduate student development. For instance, studies of graduate education and graduate student development often focus on socialization, the process by which scholars gain the knowledge, skills, and values of graduate school and the academic profession by engaging in an academic community (Austin, 2002; Holley, 2015; Twale, Weidman, & Bethea, 2016). Researchers widely use socialization to understand the factors that facilitate and constrain doctoral student development, including the role of mentors, the institutional climate, organizational culture, sense of community, and student engagement (Hirschy, Wilson, Liddell, Boyle, & Pasquesi, 2015; Jeong, Litson, Blaney, & Feldon, 2019; Luedke, Collom, McCoy, Lee-Johnson, & Winkle-Wagner, 2019; Portnoi, Chlopecki, & Peregrina-Kretz, 2015; Twale et al., 2016). However, because of the pervasiveness of disciplines on institutional and departmental structure and culture, most of these studies take place within the context of traditional, disciplinary degree programs, giving little insight into the features of graduate training that can promote the development of students with interdisciplinary research interests.

The handful of studies that focus on graduate student development in interdisciplinary contexts show these students experience different developmental processes given their position at the intersection of multiple fields, which may have different knowledge paradigms or higher or lower degrees

of consensus (Gelfand & Jackson, 2016). Several of these studies (e.g., Boden et al., 2011; Gardner et al., 2011; Gardner et al., 2012, 2014; Newswander & Borrego, 2009) draw data from NSF-funded programs like IGERT. These studies suggest students in interdisciplinary graduate programs face unique and sometimes challenging socialization experiences. For instance, interdisciplinary graduate programs often lack cohesive, long-term curricular opportunities in which students gain the skills needed to do interdisciplinary research (Boden et al., 2011; Gardner et al., 2012). Lack of structured developmental opportunities can cause uncertainty and confusion for students, which therefore undermines their academic socialization (Gardner et al., 2012). Faculty members' ability to teach and mentor students in interdisciplinary research are often hampered by their own disciplinary socialization and constraints on their time to learn and integrate new approaches to teaching and research (Gantogtokh & Quinlan, 2017; Gardner et al, 2014). In other words, socialization is not a straightforward process for interdisciplinary doctoral students, but rather one in which students must navigate a complex institutional environment in addition to developing the skills and qualifications needed to complete their degree and become successfully socialized.

THEORETICAL FRAMEWORK

SCHOLARLY IDENTITY DEVELOPMENT

In this study, we focus on one aspect of graduate student development: scholarly identity, which occurs within the context of graduate student socialization (Holley, 2015). Broadly, identity refers to "being recognized as a certain kind of person" (Gee, 2000, p. 99). Examples of different identities include student, woman, teacher, or an academic. By scholarly identity, we refer to the ways academics see themselves (and are seen by others) as legitimate, contributing members of their academic field, discipline, and/or scholarly community (Baker & Lattuca, 2010; Carlone & Johnson, 2007; Holley, 2015; Inouye & McAlpine, 2017; Lyall, 2019; McAlpine et al., 2014). Although graduate students simultaneously develop their identities as both students and scholars over the course of their doctoral training, upon completion of their degrees, they shed their identities as students (Baker & Lattuca, 2010; Baker & Pifer, 2011; Jazvac-Martek, 2009). Scholarly identity is distinct from doctoral student identity in that the latter is tied to one's temporary position within an institution, whereas the former focuses on one's location within "a discipline and institution based on one's research contributions" (Inouye & McAlpine, 2017, p. 3).

Students develop scholarly identities around their roles as individuals (e.g., as a researcher or teacher) and also as group or community members (e.g., as a part of a department, institution, and discipline) (Baker & Lattuca, 2010; McAlpine et al., 2014). These identities co-exist (Baker & Lattuca, 2010; Jazvac-Martek, 2009). For example, one might develop an identity as a scientist in the broad sense, but also develop an identity around being a biologist and specifically a plant biologist. Scholarly identity changes over the course of time, and particularly may shift during doctoral training as students continue to accumulate knowledge about their scholarly community (Baker & Lattuca, 2010; Baker & Pifer, 2014; McAlpine et al., 2014). As doctoral students become acclimated to the academic world and to their discipline, they simultaneously develop a sense of how to define themselves as scholars and how to define others ((Baker & Lattuca, 2010; Baker & Pifer, 2014). These definitions are socially constructed and attached to role labels that reflect the general expectations, behaviors, and values of the academy and their specific scholarly or disciplinary community (Baker & Lattuca, 2010).

There are multiple ways students build and demonstrate their scholarly identities. For instance, studies show students who demonstrated scholarly identities as scientists were those who 1) were competent in their understanding of scientific knowledge; 2) who recognized themselves and were recognized by others as legitimate scientists; and 3) who performed or engaged in the characteristic actions of their science identity on a regular basis (Baker & Pifer, 2011; Carlone & Johnson, 2007; Dollarhide, Gibson, & Moss, 2013; Hudson et al., 2018; Jazvac-Martek, 2009). The ability to make bids for external recognition and to perform scholarly identity takes place within the context of graduate

learning experiences, such as joining research teams, presenting at academic conferences, publishing research in scholarly venues, and receiving mentorship from faculty members (McAlpine et al., 2014).

A range of factors shape a doctoral student's scholarly identity. First, students' social identities (Hazari, Sadler, & Sonnert, 2013; Luedke et al., 2019) and experiences prior to graduate school (McAlpine et al., 2014) may influence how they view themselves as scholars in their field. Second, structural, institutional, disciplinary, and departmental factors may also signal to students the types of scholarly traits that are valued within the academy or their field (Baker & Lattuca, 2010; Holley, 2015; Lyall, 2019; O'Meara, 2013; O'Meara et al., 2014). For example, certain disciplines may favor particular epistemological orientations that graduate students come to view as legitimate. Third, networks, such as the faculty members and peers with whom students interact, influence scholarly identity by role modeling certain types of scholarship or values (Baker & Lattuca, 2010; Inouye & McAlpine, 2017; Holley, 2015; Niehaus & O'Meara, 2015; McAlpine et al., 2014; Sweitzer, 2009) or by recognizing a scholar's performance of their identity (Carlone & Johnson, 2007; Hudson et al., 2018).

Students may experience challenges in developing a scholarly identity. Scholars may experience stress when their research interests come into conflict with the ones espoused by their faculty mentor (Baker & Pifer, 2014). Scholarly identity development can be undermined when institutional cultures or norms do not affirm an individual's intellectual or scientific values (Baker & Lattuca, 2010; Lyall, 2019). They may experience identity dissonance when they lack the skills needed to fulfill their scholarly role (Baker & Lattuca, 2010; Hudson et al., 2018).

These challenges may be more prominent for students with interdisciplinary research interests. For example, students in interdisciplinary STEM doctoral programs may lack role models with interdisciplinary training who can provide mentoring on their multidisciplinary projects (Gardner et al., 2012). Interdisciplinary scholars can also face challenges in finding an intellectual community that legitimizes their scholarly interests and values or provides opportunities to perform their identities (Gonzales & Rincones, 2012; Lyall, 2019). They may struggle to balance the demands of gaining expertise and building relationships across multiple disciplines – particularly if institutional structures are not in place to facilitate student learning (Gantogtokh & Quinlan, 2017; Gardner et al., 2014; Holley, 2009; Lindvig, 2018; Lyall, 2019). Such disparities in recognition and legitimization as scholars can impede the development of scholarly identity.

There are several reasons why graduate programs, particularly those seeking to train interdisciplinary researchers, should care about scholarly identity development for doctoral students. Students who enact, perform, and receive positive recognition for their scholarly identities may experience greater satisfaction with their doctoral programs, enhanced completion rates, a greater sense of purpose within their scholarly work, and higher persistence within scientific careers (Carlone & Johnson, 2007; Baker & Pifer, 2011, 2014; Hudson et al., 2018). Thus, graduate programs that can help students nurture their scholarly identities may experience greater success at developing researchers who meet global, interdisciplinary scientific needs. With this potential in mind, the goal of our study is to understand how graduate programs shape doctoral students' scholarly identities as interdisciplinary scientists.

METHODOLOGY

For this case study, we utilized ethnographic qualitative case study methods (Merriam, 1998; Yin 2018) to understand how one National Science Foundation-funded National Research Traineeship (NRT) program influenced students' scholarly identities as interdisciplinary scientists. Cases are single-bounded units (Merriam, 1998; Yin, 2018): in our study, the bounded unit was the NRT program at the University of Maryland, which is situated within the larger context of the UMD Language Science Center. Case study methods are appropriate for research designs guided by how or why questions and in research settings in which programs are being studied or evaluated (Yin, 2018), thus making it a suitable method for understanding UMD's NRT program. Case studies are also useful for

comprehending complex processes and for building theories of how and why processes work, which makes it an appropriate tool for evaluating the process of scholarly identity development within the NRT program (Yin, 2018).

The LSC has been nationally and internationally recognized for the success of its graduate program, in many ways navigating many of the known barriers to creating quality interdisciplinary training for students. Evidence of their success includes: successive NSF grants (IGERT, NRT), institutional funds for the creation of the center, LSC leaders being sought after to give invited talks about graduate education at other research institutions, and international research awards for interdisciplinary language research (Johns Hopkins Center for Talented Youth, 2018; Language Science Center, 2016). Given this success, the Language Science Center is an unusual case. Unusual cases are useful for understanding the conditions under which notable success occurs (Patton, 2014; Yin, 2018). For instance, Posselt, Reyes, Slay, Kamimura, & Porter (2017) used a case study approach to understand the aspects of one graduate program that had successfully recruited and retained Black doctoral students in the field of physics. This case was unusual in that physics is a field typically characterized by low diversity. Said another way, by focusing on a successful case or program where others have experienced more challenges, we garner insights for improving typical programs (Patton, 2014).

Positionality

Before discussing our case context, we present our own positionality and relationship with the research topic, that is, how our identities as scholars and practitioners may influence our work (Bourke, 2014; Merriam, 1998; Throne & Bourke, 2019). Our research team is composed of one higher education faculty member and two higher education doctoral students interested in graduate education. We brought both insider and outsider perspectives to this research. As scholars of higher education, a professional field outside of STEM, we brought outsider perspectives in that we have not been trained in the hard sciences and, in particular, are outsiders to the language science fields on which our case study focused (Bourke, 2014; Malkki, 2007; Throne & Bourke, 2019). This perspective allowed us to approach our research questions with an outsider's view, inquiring about the norms, cultures, and values of unfamiliar disciplinary fields. On the other hand, as higher education scholars, we also brought insider perspectives to the project (Bourke, 2014; Malkki, 2007; Throne & Bourke, 2019). Because higher education is a field of inquiry that draws on the insights of multiple disciplines (Perna & Thomas, 2008), our views of interdisciplinary scholarly identity are shaped by our own experiences finding common ground between disciplines and navigating across conceptual and theoretical frameworks. Multiple perspectives strengthened our study by allowing us to at times identify with participants while also questioning practices, policies, and norms within the program.

Case Context

Our case was the University of Maryland's (UMD) NRT graduate training program in the language sciences, which operates within the larger institutional context of the nationally-recognized Language Science Center (LSC). In 2008, NSF awarded UMD an IGERT grant, focused on enhancing graduate students' interdisciplinary research skills in the language sciences. As part of the grant, faculty members from nine departments in five colleges collaborated to create a graduate training program that included both curricular and co-curricular components. The IGERT grant funds catalyzed the creation of a language science community across UMD's campus. With the success of the grant, institutional leaders provided campus support for the creation of the Language Science Center in 2013.

The Language Science Center now operates as interdisciplinary, collaborative network of 20 academic departments/units, with over 200 students and faculty members in fields including but not limited to linguistics, hearing and speech sciences, computer science, education, and psychology. The LSC has a physical location on campus that features office and classroom space, as well as meeting space for students. There are three full-time professional staff members, including faculty who staff the Center.

The LSC includes programming for both undergraduate and graduate students and consists of multiple program staff, affiliate faculty, and a regular programming schedule for students across UMD's campus. LSC events include Language Science Day, an annual celebration held each fall to gather members of the language science community and highlight student and faculty accomplishments and research; Winter Storm, a two-week training workshop for graduate students during the winter term; and Language Science Lunch Talks, a weekly research talk given by students or faculty to an interdisciplinary audience. Over the years, LSC programs also involved student and faculty reading groups and science outreach events in partnership with the local community.

The NRT program began in 2015 and is guided by several goals for graduate student development, as well as goals focused on enhancing graduate education and institutional practices that facilitate interdisciplinary research. One of the goals is to enhance student scholarly identity as interdisciplinary scientists or, what the LSC calls "language scientists." Accordingly, the NRT program designs many of its activities to give students opportunities to learn about other disciplines and collaborate on interdisciplinary teams (See Table 1 for NRT Graduate Student Training Activities). The NRT program provides direct funding for doctoral students training in the language sciences in the form of both stipends or funding for specific professional development and training activities (e.g., conferences, internships). Doctoral students apply for the NRT program during their first year of graduate school, after being admitted into their home departments. During the application process, students identify potential mentors from outside their home department and develop an interdisciplinary research proposal, which in many cases, turn into their dissertation research. Once they are accepted into the program, NRT students are required to participate in a variety of activities in the Language Science Center, including giving an annual interdisciplinary research talk in the LSC, attending LSC events, and completing a policy internship. However, most of these activities are open to any graduate students who want to participate in the LSC.

Table 1. NRT Graduate Student Training Activities

Science Policy Internships
Trainees take part in a science policy internship that is meant to deepen their understanding of how their research connects to societal concerns and has the potential to address real-world problems. The internship is also meant to contribute to public awareness and policy on language-related issues. Students have interned at international science policy-making organizations, Washington DC nonprofits, and disciplinary associations.
Winter Storm
This cross-departmental, two-week training workshop is held annually between the Fall and Spring semesters and is meant to provide students with an opportunity for focused collaboration, technical skills training, and science communication training. During the two weeks, students participate in research methods workshops, faculty lunch talks, special interest groups, technical training, professional development, and presentations.
Lunch Talks
These cross-departmental events occur weekly and provide students and faculty an opportunity to present in-progress work to an interdisciplinary audience. Students witness and practice communication for diverse audiences as they take part in coordinating the event, presenting at it, and interacting with presenters as an audience member. The typical audience size is 30 with a mix of 40% faculty and 60% students from multiple LSC affiliated departments.
Outreach
Regular outreach opportunities include hosting high school visitors to campus, partnering with a high school linguistics club, participating in science fairs at elementary schools and regional festivals, and offering activities at a booth during an annual campus wide event called Maryland Day. Outreach gives students an opportunity to practice communicating science to diverse audiences, including non-academics. Outreach also gives students a sense of the impact of their work beyond academia and the opportunity to build their network and work collaboratively with students outside of their home discipline.

Language Science Day
Language Science Day is a cross-departmental, annual event for the entire university language science community. Throughout the day, students display and present current projects, hear about research and training opportunities, and network with potential collaborators. This event serves as a sort of community orientation for new members and provides students an opportunity to witness and practice communication for diverse audiences and expand their networks.
Student Committees
NRT students participate as both members and chairs of student committees within the LSC. Student committees coordinate the bulk of the key events and activities in the program, and leadership in the committees develops student communication skills and strengthens connections with peers and faculty across disciplines and research areas. Committees include Research and Skills Collaboration, Professional Development and Communication, and Outreach.
Research Teams
NRT students and faculty participate on numerous interdisciplinary research teams that are formally and informally supported by the Language Science Center. These interdisciplinary research teams grant students the opportunity to collaborate with students and faculty from outside of their discipline, practice interdisciplinary communication, find areas of common interest across disciplines, and deepen their network connections with colleagues with whom they may not otherwise interact. Examples of interdisciplinary research teams include the Language Diversity Taskforce, a field station in Guatemala, and a collaboration between students and faculty in natural language processing (NLP), computer science, and linguistics that infused linguistics insights into NLP technologies.
Interdisciplinary Courses
The LSC sponsors interdisciplinary courses (sometimes referred to as seminars) on a regular basis. These courses are sometimes co-taught by LSC-affiliated faculty or cross-listed in multiple departments. The seminars give students the opportunity to learn about the disciplinary tools and methods from disciplines outside of their own, build connections with students and faculty from other departments, and learn about research problems shared across disciplines. Examples of co-taught courses include "Language and Poverty: Beyond the Word Gap" and "Violently Multidisciplinary Language Seminar."

One important distinction is between the NRT program and the activities of the Language Science Center generally. As previously discussed, the NRT program operates within the larger context of the LSC. For NRT students, the requirements of the NRT program and the activities of the Language Science Center overlap. From the students' vantage point, the NRT and the LSC are experienced as interchangeable or synonymous. Thus, although we focused our data collection on students in the NRT program, it is likely that non-NRT doctoral students who participate in LSC activities benefit from the interdisciplinary and professional development programs the Center offers.

DATA SOURCES

Our data sources included student interviews, student and faculty focus groups, ethnographic observations, and document analysis (See Table 2 for Data Sources). Qualitative data from students were collected via one-on-one interviews and focus groups. We conducted interviews with students on a rotating basis about mid-way through their program and follow-up interviews with students around the time they completed their doctoral degrees. Interviews lasted approximately 30 minutes to one hour and were guided by a semi-structured interview protocol (Creswell & Creswell, 2018; Bogdan & Biklen, 2007). We also conducted three focus groups with students (one per year) that were semi-structured in nature. To maintain participant confidentiality, we do not identify NRT students by their year in the program, specific research topic, or home disciplinary affiliation, but rather refer to "NRT students" in the aggregate.

Table 2. Data Sources

Type of Source	Date	# of Participants Per Event*
Observations		
Language Science Center Community Meetings	Spring 2015, Fall 2017	40
Language Science Day (3)	Fall 2015, 2017, 2018	200
Winter Storm (4)	Winter 2016, 2017, 2018, 2019	50
Outreach Activities (5) (Maryland Day, Science Career Day, STEM Festival)	Spring 2016 – Spring 2018	20-250
Lunch Talks (6)	Fall 2016 - Spring 2018	30
Focus Groups		
Student Focus Group 1 was attended by students who were a part of the language science community, were NRT fellows, or were in the process of applying to become fellows.	Spring 2016	10
Faculty Focus Group 1 was attended by those serving as advisors/mentors for NRT students.	Spring 2016	7
Student Focus Group 2 was attended by active NRT fellows.	Fall 2016	11
Faculty Focus Group 2 was attended by those serving as advisors/mentors for NRT students.	Fall 2016	4
Faculty Focus Group 3 was attended by those serving as advisors/mentors for NRT students.	Fall 2017	3
Student Focus Group 3 was attended by active NRT fellows.	Spring 2018	13
One-on-One Interviews		
Interviews with the majority of Cohort 1 students	Fall 2016	5
Interviews with the remaining Cohort 1 students (2) and all Cohort 2 students	Spring 2017-Fall 2017	8
Interviews with Cohort 3 students	Spring 2018	5
Interviews with graduating Cohort 1 students	Spring 2018	5
Interviews with key institutional informants	Fall 2018	3
Student Applications and Progress Reports		
Students submit applications to join the NRT fellowship.	Fall 2014 – Spring 2018	19
Students submit regularly updated progress reports. The applications and the progress reports contain each student's CV, research and professional goals, and a research proposal.	Spring 2016 - Spring 2018	19

*Participant numbers for observations are approximate

We additionally conducted three semi-structured focus groups with faculty members involved with the LSC. Faculty participants included faculty members who served as advisors or mentors – both formally and informally – to students in the NRT program. Focus groups lasted approximately one hour and were semi-structured in nature (Bogdan & Biklen, 2007; Carey & Asbury, 2016). We also conducted semi-structured interviews with key institutional informants (such as faculty members involved with the NRT program and graduate school administrators) to understand the context for graduate education at the University of Maryland. Similar to our protocol with students, to maintain faculty confidentiality, we do not discuss faculty or administrator characteristics such as rank or disciplinary background.

Questions in the interviews and focus groups pertinent to this study emphasized student experience in the NRT program and Language Science Center more broadly, with a particular focus on how activities or experiences shaped scholarly identity. For example, we asked students to discuss new research skills they acquired since starting the NRT program and to identify the ways their networks had grown.

Finally, we conducted approximately 50 hours of ethnographic observations at a variety of Language Science Center events. Observations offer researchers the opportunity to see firsthand the phenomenon of interest (Creswell & Poth, 2017; Merriam, 1998). In this case, observations allowed us to see how NRT students developed and demonstrated their interdisciplinary scholarly identity during research talks, outreach events, or professional development workshops. Our observation protocol (Creswell & Poth, 2017) cued us to pay attention to how the NRT program goals were achieved (or not) at each event. One of those goals was related to the development of an interdisciplinary scholarly identity. As such, we observed how participants interacted and communicated with one another (Merriam, 1998) in ways that affected that goal. In addition to participant observations, we also had access to NRT students' application materials and curricula vitae (CVs), which helped us to better understand the breadth of interdisciplinary projects and trainings students participated in and the extent their work and interests changed over time.

Data Analysis

To analyze our data, we used both deductive and iterative approaches (Rossman & Rallis, 2016). We first used a theory-based, deductive coding method (Saldaña, 2016; Yin, 2018) based on theories of scholarly identity development. We read and re-read the transcripts and notes from observations and coded them with scholarly identity development in mind, paying attention to passages of transcriptions or observational data related to students discussing or demonstrating aspects of their scholarly identity. For instance, we noted areas where students discussed how their perspectives on their discipline changed or were influenced by the NRT program. We also noted the specific elements of the NRT program that seemed to contribute to scholarly identity development, including patterns we saw that may have been less evident to individual participants, particularly within the observational data. In the next round of analysis, we re-analyzed the passages we marked related to scholarly identity development and constructed themes around the ways the NRT program influenced development of an interdisciplinary scholarly identity (See Table 3 for an overview of the major themes and illustrative quotes). Our research team developed memos on the major themes and debriefed them as a group several times, which strengthened our analytic findings.

Table 3. Illustrative Quotes for Each Theme

Theme	Illustrative quote
Creating an interdisciplinary network of faculty and peers.	As soon as I showed up, I knew that I wanted to get involved with different events and different things around campus because that was the sort of approach that really appealed to me. The fact that people actually talked to each other across departments and collaborated on different projects. That there was actually this sort of collaboration rather than competition in getting things done.
	I have this vivid memory of the reading group, the one that split with [Faculty Member A] and [Faculty Member B]. Someone in [STEM field] was presenting and [Faculty Member A] got really energetic, telling them that they have to read about [social science field]…because [scientists in the social science field] think "this, this, this" and it might blow their mind, but they should really try to engage with that. That was a case where it came out very explicitly, this is how you might think about but this is how other people might think about it.
Developing competence in methods,	It [the NRT program] opens the doors for our students to take courses to prepare them to work with sophisticated, contemporary

Theme	Illustrative quote
language, and perspectives of other disciplines	technology. To meet faculty outside our small group and work in different projects. For our students, it is mostly enrichment in all possible.
	Getting training in [research method] has led me to participate in reading groups in [discipline A] and a joint group with [discipline B], to hear a lot more about what people on the [discipline A] side of things think about language, how they work with language, and what their perspective is on the types of work that [people in my discipline] do.
	They [scientists in another discipline] have totally different ways of setting up their experiments… it's all [research method] which is not really something that I do…There are just kind of basic fundamental differences that I feel like I have a better grasp on. In fact, my advisor has come to me and been like, 'Hey, we need to figure out how to pitch our stuff as something that these people would care about. Now you've read a bunch of these papers, let's talk about how to do that.' So I feel like that's really something that I've learned about another field.
Finding common ground between disciplines	I took a class and it was half [discipline] people. It was cool because you get to see that they actually do care about some of the same things that I care about…it definitely bridged the first barrier of 'who are these people, who specifically cares about the same kind of things?' I feel totally comfortable sending someone who I was in class with an email that's like 'hey, I'm interested in this, want to meet in the LSC?'
	I've taken a [discipline] course because of the Language Science Center and my involvement, which I never would have done before. It's made my research question that much more interesting because now I see how my area interacts with some other field that I've never considered before, and how they feed into one another.
	It's good to know about people and what they are interested in and what they take to be a successful research program, but sometimes frustrating. I am sure they felt the same way about me and some others in the class who were going in a different direction about how we wanted to steer the conversation. But I guess that is to be expected when people are coming from different backgrounds.
Broadening view of research impact and applications	[Language Science Day was] a really powerful moment to see and think about the bigger picture. On a day-to-day, embedded in research, we're always thinking about this very narrow specific topic…you always forget this leads into something much larger than this tiny, miniscule thing that I'm working on. And that's not just inspiring, it's really great for thinking about where the future of language science is headed in terms of what we should be concerned about over the next 10-20 years.
	It's a policy, your approach to therapy, and what you have science backing up in your approach. I'd say this issue of the achievement and having worse language skills when you come from a family that is below the poverty line, I think that has huge implications for policy.
	I got a better idea of, these are elementary school kids, that's the kind of kids that come into our lab. Just being around them, being with their families, seeing what their family dynamics are, I got a better idea of what they need in their lives.

TRUSTWORTHINESS AND LIMITATIONS

Our research team took multiple steps to ensure our results were trustworthy. Multiple data sources enhanced the rigor of our results by allowing us to triangulate themes from interviews, focus groups,

observations, and documents (Corbin & Strauss, 2014; Yin, 2018). In particular, although we conducted focus groups and individual interviews with students, individual interviews allowed students to describe personal examples of their scholarly development that they may have felt uncomfortable disclosing in front of a large group (Carey & Asbury, 2016). Participants, including both faculty members and students, were informed about the purpose of our research. We took time at the beginning of each academic term to introduce ourselves to NRT students so they knew who we were at events throughout the year. We used the same observation protocol and semi-structured interview protocols at all data collection events (Creswell & Creswell, 2018). We collected data over a four-year period (2015-2019), which allowed us to see changes in students' scholarly identity development over time. We kept the NRT program staff abreast of our activities by sharing summaries of our key findings after the completion of data collection activities, such as interviews or focus groups (Maxwell, 2012). We conducted a thematic member-check (Creswell & Miller, 2000; Thomas, 2017) with LSC leaders, staff, and students by presenting key findings via memos, reports, and/or summaries to them and receiving feedback. For example, we discussed our initial findings with LSC leaders, and they called attention to the ways students' use of the term "language scientist" was, by itself, a signal that they had adopted a more interdisciplinary scholarly identity. Based on this feedback, we went back to our data and noted the places where students used the term, which strengthened our findings.

Though our research team took multiple precautions to ensure this study was trustworthy, including triangulating findings across multiples sources of data and collecting longitudinal data for over four years, there are several limitations to our study. First, a requirement of the NRT program is that students have some level of interest in interdisciplinary research, so isolating the magnitude of the effect of the LSC on NRT students using quantitative terms is difficult. We noted students had varying experiences and training in other disciplines. For instance, some students received their bachelor's or master's degrees in a language science field while others did not. Thus, some students started their developmental journey towards becoming an interdisciplinary scientist prior to graduate school. Although our interview and focus group questions asked students to compare their perspectives at the beginning of the program to their current views towards interdisciplinary research, we note this as a limitation.

Second, our data revealed, and we explicitly name, multiple program activities (e.g., interdisciplinary courses, Winter Storm) as influential for student scholarly identity development. We do so in order to identify activities that other graduate programs might implement to train interdisciplinary researchers. However, we recognize that the overall context and climate for interdisciplinary graduate training with the NRT, LSC, and UMD more generally contributes to scholarly identity development. Programs that adopt one or two of the NRT program activities may not experience automatic success and we caution readers from overinterpreting our results.

Last, our study is guided by the assumption that NRT students identify in some way as an interdisciplinary scientist. As noted, this assumption seems warranted in that students who apply for the program express an interest in developing their interdisciplinary research skills. However, we note that, perhaps unsurprisingly, participants in our study demonstrated different kinds of interdisciplinary scholarly identity. As our results reveal, some consider themselves bridge-builders between disciplines whereas others were more likely to indicate they used the methods of other disciplines to address questions squarely within their home discipline. This finding is consistent with past research (e.g., Gantogtokh & Quinlan, 2017; Gardner et al, 2014; Lattuca, 2003; Lyall, 2019; Müller & Kaltenbrunner, 2019), which shows that there are multiple ways interdisciplinarity can be enacted and performed. While the kinds of interdisciplinary scholarly identity students demonstrate is beyond the scope of this paper and we revisit it in the conclusion, we note this an important assumption before we discuss our findings.

FINDINGS

Our findings show UMD's NRT program, within the context of the greater Language Science Center, facilitated students' scholarly identity development as interdisciplinary scientists by creating (or plugging into) a vibrant network of interdisciplinary researchers across campus; developing doctoral student competence in the methods, language, and perspectives of disciplines other than their own; encouraging doctoral students to find common ground between disciplines; and broadening doctoral students' views of the potential impact and applications of their work.

CREATING AN INTERDISCIPLINARY NETWORK OF FACULTY AND PEERS

One of the most critical components of the NRT program that shaped students' interdisciplinary scholarly identity was access to a vibrant professional network of researchers and practitioners interested in the language sciences. Networks in this case included undergraduate and graduate students, faculty, administrators, and other language scientists with whom participants interacted, learned, and worked. Through the NRT program, participants built and strengthened connections to language scientists both on and off Maryland's campus. These connections allowed students to gain an appreciation for how interdisciplinary research projects work and for how multidisciplinary perspectives can benefit the research process.

The NRT program's location within the greater Language Science Center provided an important network scaffolding by which students became exposed to and made initial connections with students and faculty from outside of their own disciplines. Participants frequently shared that they became officially introduced to UMD's language science community at Language Science Day, an annual event that occurs each fall. Through our observations, we came to know Language Science Day as a large, interactive, and energetic event that in many ways resembled an orientation. At one Language Science Day, students, faculty, administrators, and government officials mingled and ate lunch together before the program began. As the program started, LSC staff introduced a senior UMD campus administrator, who spoke about the broad scope of the LSC activities and the contributions of the center to the campus' overall research endeavors. Then, LSC administrators discussed new initiatives and, in particular, highlighted ways for students to get involved in leadership opportunities. Subsequent speakers, faculty members from both UMD and outside of campus, highlighted their recent research projects, including field work at an international research station, language science advocacy on behalf of indigenous peoples, and a school-based language intervention program. Thus, as students heard from presenters, they gained an awareness of the diversity of individuals who composed the language science network. One participant said that as a new student, the event served to highlight "how broad language science is" and gave her insight into the range of individuals with whom she might collaborate and the multiple ways that she might get involved with the LSC.

The LSC, as a physical location, also acted as an interactive hub of activity where students and faculty members regularly met and deepened their network connections over time. Weekly events like Language Science Lunch Talks (LSLTs), weekly student and faculty research presentations during lunch, allowed students to become familiar with the people associated with the LSC network, better understand their research interests, and develop a sense of community. Upon entering the LSC during one LSLT, we observed students and faculty members interacting with each other in a relaxed atmosphere, sharing lunch, and conversing with one another. Once the student presenter started her talk, the audience members gave substantive feedback as one might expect during a formal research presentation. However, the student presenter also incorporated jokes and humor throughout the presentation, giving the experience a more informal feel. Likewise, when she experienced technical difficulties, she casually chatted with the crowd as the glitch was addressed. This relaxed atmosphere helped students become comfortable with interacting with students and faculty members from out-

side of their home discipline and strengthened their connections. One student said the weekly gathering "help[s] facilitate that [the network] a lot because you see the same faces every week, share lunch together, and get to hear what people from lots of different fields are doing."

Regular access to the LSC's interdisciplinary network also gave students the opportunity to learn more about other fields. One student explained the ways the LSC built his interdisciplinary network by saying:

> I've been able to plug into the [social science discipline] program here…I definitely feel like that's informed my research and my thinking in ways that a lot of the students in my own program are missing if they aren't plugged in. The way I think about my field tends to be quite different than a lot of the students who are just doing my field. I get to see that in interactions with those people.

As this student shared, the existing LSC network eased new participants' ability to make connections with faculty members and students in other departments. The interdisciplinary network of the LSC therefore shaped scholarly identity by giving graduate students opportunities to substantively engage with individuals that they otherwise may not have met.

The LSC network furthermore gave students access to interdisciplinary role models and mentors who provided examples of the ways students might undertake interdisciplinary research problems. Role models and mentors included those who do interdisciplinary work and those from disciplinary backgrounds different from the students' home discipline. Multiple students shared that by observing faculty members who do interdisciplinary work give feedback or ask questions, they gained an ability to see things from an interdisciplinary perspective. For example, one student said that during Language Science Lunch Talks, she spent a lot of time observing faculty members. She stated, "whenever faculty talk…I'm trying to figure out what they are saying, why they are interested, and why they are asking that question." Multiple students likewise said that figuring out the questions that piqued the interest of researchers from other fields was one of the critical things they learned from faculty members who participated in the LSC community.

Opportunities to observe how faculty members performed their interdisciplinary identities by way of questions in public settings gave students insight into the norms and values of other disciplines. Such examples challenged participants to see their own research from a different perspective. We observed faculty role modeling multiple forms of interdisciplinarity during one Language Science Day, an annual event that takes place each fall. During the plenary session, a panel of faculty members from different disciplines discussed the theoretical landscape of language science. During the panel, four faculty members – all language scientists – discussed the paradigms, goals, and values that guided their research. They suggested while there were multiple avenues for collaborations between fields, there were also places or questions where collaborations were less useful. During the panel, one faculty member suggested that he did not see himself as a scholar who shared research interests with other disciplines but, rather, as a scholar who could use the tools of other disciplines within his work. He said, "I don't see myself as interdisciplinary, I see myself as asking highly disciplinary questions by borrowing tools from other disciplines." A few minutes later, another faculty member presented a different view of interdisciplinarity. As she explained her collaborative approach to a recent research problem, she said that the project "highlights an area where we can't solve the problem unless we put all of our heads together." This panel therefore showed students that, although there are areas of shared interest between disciplines, there is not a "one-size-fits all approach" to being an interdisciplinary language scientist.

Developing Competence in Methods, Cultures, and Perspectives of Other Disciplines

Another way the NRT program developed students' scholarly identity as interdisciplinary scientists was by increasing their competence in the methods, cultures, and perspectives of disciplines other

than their own. First, NRT activities facilitated students' knowledge of the methods, tools, and other technical skills commonly used in other disciplines. Our data revealed students demonstrated a knowledge of the methods used by their peers and faculty mentors from other disciplines. For example, one student said that though she did not initially identify as a certain kind of scientist, coursework in another discipline had shifted her identity in that direction:

> The course that I was taking was 50 [STEM field graduate students] and two [students from a social science field] and it was very much geared towards [the former]…In the course…they would teach some very simple [theories from the social science field] and we would be like, 'Oh yeah we totally know this!' And then they would be like, 'Ok now go implement this thing,' because the majority of the folks in the class were used to that. So, it's the reverse of what we had. It was a lot of catch up to do. It was very challenging but super valuable.

In other words, interdisciplinary course plans helped students understand the methodological approaches of other disciplines. Progress reports and CVs confirmed many NRT students participated in coursework, professional conferences, and trainings that gave them access to research training outside of their home discipline and beyond, and they utilized these methods in their subsequent work. These opportunities facilitated NRT students' scholarly identities as interdisciplinary scientists by allowing them to see research problems through multiple disciplinary lenses and developing competence using the research methods or tools from other disciplines.

The NRT program further increased doctoral student competence in using the tools of other disciplines by giving them access to faculty members and peers who could provide feedback and strategic advice. Multiple NRT students indicated they went to faculty members affiliated with the LSC in the initial stages of their research to get feedback on methods. One student said that when her team began working with an unfamiliar method, explaining, "We consulted with a psychologist on campus to get his perspective and to get his advice on whether or not this would be a good adaptation of his methods."

Our observations showed that giving and receiving feedback was a key feature of many LSC events. For example, during Winter Storm, the annual two-week training workshop, one session focused on developing a research elevator pitch, or a succinct introduction to one's research topic. One NRT student led the workshop and gave her advice on how to develop an elevator pitch that would be relevant for diverse academic audiences. Then, two students gave examples of their elevator pitches, and the audience gave feedback on what they liked about their presentation. Students commented they liked elevator pitches that started with questions or those in which the presenter related their research to the audience. Students spent individual time writing their elevator pitches and paired up to practice with one another, giving each other feedback and advice on strengths and areas for improvement. The collegial, interactive environment within this student-led workshop allowed students to gain valuable, interdisciplinary feedback on how to improve their science communication. The NRT program facilitated interdisciplinary feedback in ways that allowed participants to gain advice on the technical aspects of their work and to receive recognition from interdisciplinary audiences about the importance of it. Said another way, the feedback students received through NRT activities legitimated their interest in doing interdisciplinary research and affirmed their collaborative work would be respected and supported.

Through the LSC, NRT students gained knowledge of disciplinary norms and cultures and developed strategies that helped them navigate these differences. For example, several students indicated that the research culture of one specific STEM field was significantly faster paced than the norms of their own field. For example, one student stated, "you need faster turnaround for some of the work, because it's cutting edge, and people are using that in companies." To stay up to date, the student needed to work quicker and more collaboratively compared to the norms of her home field. An increased understanding of the norms guiding different fields helped NRT students become competent

in collaborating with students and faculty members from other disciplines, thereby developing skills that students could leverage in subsequent work.

Despite the benefits of learning new cultures, the process by which students became aware of disciplinary cultures other than their own sometimes came with challenges. Cultural differences emerged between students in more applied versus theoretical fields, which sometimes made research projects difficult to get off the ground. For example, one student explained that she and her collaborators from a different discipline experienced difficulty in identifying research projects that were of interest to all members of the research team. She said, "If you can't indicate that this is going to be relevant to the real world or for an actual application, then they [scientists from a specific STEM field] don't care." This suggests that cultural differences influenced the types of projects on which NRT students from different disciplines worked. Likewise, another student said that when she first started working with students and faculty members from different fields, "There was this whole transition period with respect to what the priorities are and what they tend to think about, how they tend to think, how they tend to work, the media that they work with." She noted that although she ultimately was able to learn how to navigate these culture differences, it was a process that took time.

While NRT students demonstrated knowledge of other disciplines in multiple ways, they did not always feel confident about their competence. Multiple students indicated they had more to learn or hoped for more opportunities to get to know other disciplinary methods. One student said:

> If I had more time and could develop a better understanding of where all the different disciplines are and what they think, then it would be so much easier to collaborate to try to take on other people's perspective…I have some idea of the big kind of research questions, but I don't have an idea of how these other fields progressed through time and where these people are coming from fully.

As implied by this student, there are multiple types of competence students in interdisciplinary programs must develop in order to consider themselves interdisciplinary scientists. Students in the NRT program demonstrated cultural competence in navigating multiple, diverse disciplinary norms and practices. Yet, they were sometimes hesitant to profess high levels of technical competence in other disciplines, despite access to courses and training which provided some of these skills. Though students demonstrated some aspects of an interdisciplinary scholarly identity in some areas, their appraisal of their own competence in possessing interdisciplinary skills was still developing.

Finding Common Ground Between Disciplines

Another way that the NRT program influenced doctoral students' scholarly identities as interdisciplinary language scientists was by encouraging them to identify common research interests and problems that spanned disciplines. First, students indicated that the interdisciplinary environment of the Language Science Center provided opportunities to find areas of shared interest across two or more disciplines and develop research projects led by interdisciplinary teams. For instance, during one Winter Storm, the LSC organized special interest sessions around different language topics and invited participants to continue meeting with their special interest group to develop an interdisciplinary research project. One student described this group:

> Recently six of us from different disciplines have come together…we started out by discussing what each of us work on, and then we brainstormed about…the projects that could be done, that we wouldn't have done if we were just with the people from our disciplines.

The NRT program therefore encouraged students to identify topics they could study together and leverage the strengths of each discipline towards a common goal. Another student described a poster session during Language Science Day, wherein she met a student from another discipline and found that they were working on a similar problem. She said:

> I was presenting this idea at one of the poster sessions and that's when I started talking with a student who was working on this same idea or this same underlying problem and that problem was [topic]. I was looking at it from a [certain STEM field] perspective and the other student was looking at it from a [certain social science] perspective, so it was clearly useful for the two of us to come together and think about how we could each contribute to the other side.

Formal program activities, such as poster sessions, created opportunities for students to find common ground and develop interdisciplinary collaborative projects. The LSC normalized this collaborative behavior and, therefore, contributed to students' interdisciplinary scholarly identity by facilitating their ability to see the value of using multiple disciplines to understand research problems.

Likewise, faculty members attested to the ways in which students participated in NRT-sponsored interdisciplinary trainings, such as Winter Storm, strengthened student research skills and developed their ability to see the benefits of interdisciplinary collaboration. During one focus group, a faculty member said:

> I know from working with my PhD students that it [the NRT program] is really pushing them outside their comfort zone. For example, people were not terribly comfortable with using speech processing software, and they hooked up with students from [social science field] and everyone brought something to the table and they could pull off a project that they would not have been able to pull off not individually, but as a team coming from one program.

Seeing the benefits of interdisciplinarity subsequently influenced the scholarly identity development of NRT students. As students gained an appreciation for the advantages of using multiple perspectives in their research, they began to see interdisciplinarity as a core aspect of the scholarly identity. One student discussed the ways taking courses outside of her home discipline fostered her scholarly identity. She said:

> I started taking [classes in a specific STEM field] and [classes in a specific social science field] and they really allowed me to learn a bunch of stuff that I had never been exposed to before. I figured out that I was very interested in this kind of stuff and that I was also very interested in trying to build these bridges between these two fields that didn't necessarily talk to each other very much. I saw a lot of potential for that to happen.

Through interdisciplinary coursework and other LSC events, NRT students not only developed the functional ability to draw from different disciplines but also began to internalize this "bridge building" as part of their identity as interdisciplinary scientists. Several students articulated their contributions to language science as specifically related to their ability to see connections between fields. For example, one student, from a more theoretical field, described the development of a project with several students from a more applied field and explained the relationship as a "natural collaboration" because of the limitations of either field in exploring their research area. These findings together suggest that the NRT program influenced student values, wherein they discovered finding common ground with other disciplines as one of the major components of their identity as interdisciplinary scientists.

While finding common ground across disciplines was encouraged in the NRT program, students found the process of discovering shared interests sometimes difficult. For example, students learned that developing a common vocabulary and way of talking about a particular research problem required significant effort at the initial stages of project planning. One student reflected:

> I learned what it was like to cooperate on a team with other language scientists, which is really hard actually because when you come from different disciplines, you spend a lot of time talking past one another before you can start talking to one another. Figuring out how to engage in effective dialogue for a common purpose was really key.

Thus, NRT-sponsored research teams allowed students to gain appreciation for the communication skills needed to work with scientists from other disciplines. NRT students also learned that the pace of interdisciplinary work was sometimes slower than what they experienced as researchers on single-discipline projects. Multiple students noted their interdisciplinary collaborations stretched over months or even years without getting off the ground and suggested there was some degree of uncertainty associated with finding common ground. For example, one student discussed a student-led interdisciplinary research project and said "I don't know where this project is going to go. It has definitely been a struggle…finding something that we are all interested in and capable of carrying out, that is interesting on both sides." While students sometimes saw these communication or time issues as barriers to participating in interdisciplinary collaborative projects, it was also clear that through these "stalled" projects, NRT students gained a sense of the persistence and patience needed to work on interdisciplinary and collaborative teams.

Although NRT students were required to participate on interdisciplinary research projects and develop interdisciplinary skills, not all students who participated in LSC events shared the same enthusiasm for doing interdisciplinary work. During one interview, a student reflected:

> There are some disciplines that are related but where people have really different goals, like [field] or a lot of people in [field]. Their goal is to make people better or have [applied] outcomes and stuff like that, which is something that I don't really care about. I mean I do tangentially, but I don't see that as the goal of my research.

This quote highlights that, while interdisciplinary research offers great potential for collaboration across disciplines, not all participants were interested in orienting their scholarship towards the same goal. However, the fact that NRT students understood the differences between disciplinary perspectives suggests that they learned how to situate their research within those goals. Said another way, through the NRT program, students were better able to place their research within the greater context of language science and gained a better sense of what their contributions to this broad field (or set of fields) could be.

Broadening Student View of Research Impact and Applications

Finally, the NRT program shaped scholarly identity development as interdisciplinary scientists by changing the ways that students viewed the importance and potential impact of their research beyond disciplinary boundaries and outside of the academy. One way the NRT achieved this goal was by giving students multiple opportunities to practice the way that they frame their research to multidisciplinary academic audiences. Language Science Lunch Talks (LSLTs) provided regular opportunities for NRT students to present their research and receive interdisciplinary feedback. NRT students often said that the talks forced them to think carefully about how to frame their research for academics with similar interests but different disciplinary backgrounds. For example, one student said the feedback she received during LSLTs tended to be focused on "bigger picture framing questions" such as "Why is this important? How are you thinking about this question? Is this the right way to approach it? How can we refine the hypotheses to make them more specific?"

Our observations of LSLTs confirmed student presenters received feedback from faculty members and students from different disciplinary backgrounds. This feedback often led students to consider new directions for their research or different ways their research could be applied to other contexts. For instance, during one student's Language Science Lunch Talk, we observed some faculty members and students asking questions pertaining to theories guiding the student's experiment, whereas others asked questions about how the experimental results could be translated to an intervention. In this case, the student was able to answer both types of questions, though the student answered more theoretical questions with the assistance of her advisor, who was also in the audience. We observed that NRT students often demonstrated high levels of what could be viewed as interdisciplinary bilingualism, wherein they were competent in formulating responses that satisfied audience members from

different disciplinary cultures. This example highlights how NRT students developed the ability and desire to communicate across disciplinary differences. They began to see that communication as an intrinsic part of their values system, thereby contributing to their scholarly identity as interdisciplinary scientists.

NRT students also participated in outreach activities wherein they interacted with non-academic audiences, which contributed to their development as interdisciplinary scientists whose work is relevant in applied settings. Almost all participants cited outreach activities as a platform for developing their ability to translate their research to practice. During observations of outreach events, we observed NRT students were highly skilled at translating their research to non-academic audiences in ways that showed their knowledge of the real-world applications of their work. For instance, during one STEM career fair, we observed NRT students using interactive science demonstrations to teach high school students about language science concepts. NRT students often began the discussion with a basic, everyday question like, "Do you know anyone who is hard of hearing?" before moving into a discussion of the ways in which sound is transmitted through the ear and the research they do on the topic. This simple framing of a question, without the use of scientific jargon, facilitated an interactive discussion between the NRT student and the high school students at their demonstration station. These types of interactions at outreach events facilitated student communication skills.

Outreach events also showed how NRT students began to value engagement with non-academic audiences. One student articulated this idea while describing her participation in outreach activities. She said:

> One goal of the outreach committee is to promote science to the public and make sure that people understand, and that we come out of the academic bubble and that we share the joy of science. But also, on the other hand, it really helps us practice the skills of, how do you think about your research in different levels of complexity, and what is it really about your research that is so important, so unique. You know, step back from the nitty gritty framework and methodological issues and what's the big picture?

In other words, outreach activities facilitated scholarly identity development as interdisciplinary scientists by giving students a platform to question and practice explaining how their research fit into the "big picture." This sentiment was echoed by multiple participants using various metaphors: zooming in and zooming out of research problems, getting out of the weeds, and seeing the forest through the trees, among others.

Likewise, NRT activities such as policy internships and science advocacy showed students the potential relationships between their research and the legislative and regulatory worlds. Some students found the challenge of bridging research and practice exciting. One student immediately recognized the policy implications for her work. She said:

> I'm very interested, as someone who studies [a specific language science problem], in understanding the broader policy implications. There is a very tangible policy implication of how do we come up with better recommendations for [education and schools]. I don't know enough about it by any means…I know the [language science] part but I know nothing about the family interaction, SES component. So that's something that…I'm really hoping to benefit from, is learning a lot more about that.

As this graduate student noted, while the NRT program opened the door to the possibility of becoming an interdisciplinary scientist who engaged in policy issues, students were still developing a sense of how their work fit in with these broader issues. Overall, NRT students not only developed the skills necessary to see the "big picture," but through program activities, NRT students began seeing the big picture as part of their core scholarly identity. They saw how they could contribute not only to science, but to society.

While all NRT students had a general understanding of the broader implications or applications of their work, there was some inconsistency in the extent to which students demonstrated an inclination or the skills needed to do so on a deeper level. For example, multiple students expressed some reservations about linking their work to policy applications. These reservations fell into two categories. Some students were still getting a feel for the policy implications of their work and the extent to which their work could contribute to scientific policy. For example, one student said while her discipline was attentive to applications, she said she was still unsure of "how my work leads to policy decisions." Other students said that while they could connect their work to the policy world if pressed, they were hesitant to do so because they had limited interest in doing science advocacy-type work. For example, one student said if they were asked to apply their work to the policy world, "we could stretch it…and I could totally do it, but this is not my primary concern." This finding suggests that, through the NRT program, students gained an awareness of and appreciation for the multiple ways their language science might contribute to the "real-world." At the same time, students conceived of this impact in different ways. While some saw connections to policy, others saw connections to healthcare, education, or industry.

DISCUSSION AND IMPLICATIONS

The path towards becoming an interdisciplinary scientist did not look the same for every student in the NRT program. Yet, our findings suggest that multiple factors contributed to the development of students' scholarly identities as interdisciplinary scientists.

Our results show that one of the major ways in which the NRT program shaped scholarly identity was by influencing their scholarly values and by reflecting those values within the larger LSC community. By values, we refer to the conscious and unconscious assumptions about what is important that guides human behavior (Schein, 1984; Thoeonig & Paradeise, 2014). Unlike prior research on interdisciplinary graduate education which shows the interdisciplinary values are often not affirmed in higher education (e.g., Gardner et al., 2012, 2014; Gonzales & Rincones, 2012; Lyall, 2019; Müller & Kaltenbrunner, 2019), the NRT program nurtured the interdisciplinary values of participants in this study. Network connections emphasized the value of collaboration and the use of multiple perspectives in approaching research problems. Outreach activities and internships gave students the opportunity to see the value in applying and extending their work and skills to clinical, industrial, or public policy settings. In other words, NRT students came to see interdisciplinary research as one of the major ways that they could contribute to language science and, thus, internalized that contribution as part of their scholarly values system.

Our results reiterate the importance of institutional context and program structure in the development of interdisciplinary scholarly identity. One of the most critical elements of the NRT program that facilitated interdisciplinary scholarly identity was that the LSC provided recognition and support for students who have interdisciplinary interests. The program, by design, was intended to break down departmental barriers that undermine interdisciplinary research endeavors (Boden et al., 2011; Borrego & Cutler, 2010; Gardner et al., 2012; Lattuca, 2001; Lindvig & Hillersdal, 2018; Lyall, 2019; Müller & Kaltenbrunner, 2019; Robinson, 2016). Whether through weekly or annual meetings of the language science community, informal reading groups, or exchanges between students in class, the LSC legitimated and encouraged students to gain research skills and launch interdisciplinary projects in ways that contributed to their scholarly identity as interdisciplinary scientists. Indeed, even the use of the term "language scientists" represented a strategic decision on the part of the LSC's program planners to create a community wherein it was an expectation rather than a deviation from the norm to participate in interdisciplinary work. These findings come into sharp contrast with prior research showing interdisciplinary researchers often face challenges in being viewed as rigorous, scientific researchers (Gonzales & Rincones, 2012; Lyall, 2019; Müller & Kaltenbrunner, 2019).

The program's formal, curricular and co-curricular structure also facilitated scholarly identity development by laying out specific goals and activities students needed to complete and giving them access to resources that helped them develop their scholarly identity. Scholarly identity development can be stymied when there is a mismatch between the type of scholar students want to become and the opportunities to gain the skills needed be that kind of scholar (Carlone & Johnson, 2007; Holley, 2015; Lattuca, 2001; Deo & Griffin, 2011). Our data revealed that the NRT program facilitated scholarly identity development by giving students access to the resources they needed to acquire the skills to develop their scholarly interests. These resources were not the same for all students. Some needed access to human resources like faculty members and students from other departments who could give feedback on their research. Others needed access to monetary resources that allowed them to develop science outreach activities and see the application of their work. The relative flexibility of the NRT program and the ability of students to create, in consultation with program staff, personalized development plans was therefore a critical component of scholarly identity development for NRT students.

Consistent with past research (e.g., Baker & Lattuca, 2010; Holley, 2015; Inouye & McAlpine, 2017; Niehaus & O'Meara, 2015; Sweitzer, 2009), our results emphasized the social and interactive nature of scholarly identity development. In the case of the NRT program, we found the feedback, evaluations, and advice students received from their networks shaped their identities as they gained more experience with interdisciplinary research. As in prior studies (Calatrava Moreno & Danowitz, 2016; O'Meara et al., 2014), we found faculty mentors and advisors were a key developmental force for NRT students. Faculty members grew student connections by introducing them to members of their own network and encouraged students to connect with other members of the language science community. Moreover, the diversity of faculty members participating in the LSC program showed students there are multiple ways students could "be" interdisciplinary language scientists. As in past research (Gonzales & Rincones, 2012; Lattuca, 2001; Lindvig & Hillersdal, 2018), faculty members in the LSC participated in interdisciplinary research in a variety of ways, using a variety of definitions. Studies suggest scholarly identity development is facilitated when students see elements of themselves in their role models and are affirmed by their role models that their contributions are valid (Baker, Pifer, & Griffin, 2014; Griffin & Reddick, 2011; Thiry, Laursen & Loshbaugh, 2015). The LSC enhanced the possibility that students would develop an interdisciplinary scholarly identity by showing students there are multiple ways they could be interdisciplinary language scientists. While some students focused on bridging theory to practice or policy, others leveraged the methods from one discipline to their own.

Finally, our results suggest that the road to becoming an interdisciplinary scientist is often a non-linear path. Not all students developed their scholarly identity in the same way or at the same rate. Though participants in this study expressed some of the same reservations about their own competence as found in studies of identity for students in discipline-based programs (e.g., Gardner et al., 2012; Holley, 2015), often their reservations were grounded in not knowing enough about another field as opposed to their home disciplines. This finding suggests that students in interdisciplinary graduate programs may develop a heightened awareness of their own, disciplinary identity, such as identity as a computer scientist, as a result of being in an interdisciplinary program. Much of their time as doctoral students is, therefore, spent figuring out how to be an *interdisciplinary* computer scientist. Previous literature shows scholars who do interdisciplinary research can experience insecurity or personal vulnerability in terms of their limited knowledge of other fields (Gardner et al., 2012; Lattuca, 2001; Lyall, 2019). Our results indicate that though NRT students were given many opportunities to develop skills outside of the ones typically used in their disciplines, they too expressed reservations about the depth of their knowledge. This hesitation to express expertise intersected with their identities as students who were still developing their own confidence and efficacy around their scholarly contributions.

There are multiple implications of this study for both practice and policy. In terms of practice, we identified multiple program elements that could be replicated by institutions that hope to enhance their interdisciplinary graduate training programs. We found that students developed their identities as interdisciplinary scientists in NRT activities, such as co-taught interdisciplinary courses, interdisciplinary research groups, outreach activities, and student research presentations, which is consistent with past research on graduate education programs and interdisciplinary graduate education programs more specifically (Boden et al., 2011; Borrego & Newswander, 2010; Gardner et al., 2012). Embedded in each of these activities were opportunities for students to give and receive feedback, see multiple ways interdisciplinarity can be enacted, and deepen their network connections, all which strengthen their scholarly identity as interdisciplinary scientists. Moreover, our results showed that these types of activities need to be sustained over time in order to facilitate the network building and student learning that contributes to scholarly identity development. That is, students need time to develop interdisciplinary competence (e.g., become familiar with the methods and tools of other disciplines) before they can begin to understand their own interdisciplinary scholarly identity. In terms of policy, our results speak to the importance of organizational structures and incentives that encourage student and faculty participation in programs like UMD's Language Science Center. For instance, given the critical importance of faculty members in directly mentoring NRT students, institutions should consider policies that will reward faculty members for their contributions to service, mentorship, and outreach in interdisciplinary graduate training programs. These rewards structures are particularly relevant when graduate programs are not officially housed a faculty member's home department.

There are several directions for future research based on this study. First, future researchers might consider the kinds of interdisciplinary scholarly identity that students develop within specific institutional contexts and within specific graduate training programs. They might wish to consider if there are certain components of graduate training that contribute to different kinds of interdisciplinary scholarly identity creation. Second, future researchers might seek to understand how students from interdisciplinary graduate training programs like the NRT continue to develop their scholarly identity as interdisciplinary scientists as they transition into post-doctoral and faculty roles. Given the emphasis of interdisciplinarity in industry and government, longitudinal studies that compare the experiences of doctoral students who go into academic versus non-academic roles would likewise be useful for informing research and practice. Given the importance of role models and mentors for doctoral student scholarly identity development, future researchers might wish to explore in more depth faculty perspectives on mentoring students from outside of their own disciplines. In particular, researchers might wish to compare the strategies faculty members use to mentor students from inside and outside of their disciplines.

CONCLUSION

In this study, we examined how one graduate education program in the language sciences influenced doctoral students' scholarly identities as interdisciplinary scientists. Our findings revealed that the doctoral students who participated in UMD's NRT program developed their scholarly identities as interdisciplinary scientists by "plugging into" a network of faculty and peers from diverse disciplinary backgrounds and through opportunities to develop technical and hard skills needed to do interdisciplinary work. Through the NRT program, students were also challenged to see and frame their research within its broader impacts and find common ground with faculty members and students from other disciplines, all of which contributed to their identity development as scientists who "do" interdisciplinary language science. Institutions, departments, administrators, and faculty members may therefore find these results informative for creating programs that foster the development of interdisciplinary scientists.

FUNDING/ACKNOWLEDGMENTS

This article describes projects that have been funded by the National Science Foundation National Research Traineeship (NRT) program, grant NRT-DESE-1449815.

REFERENCES

Austin, A. E. (2002). Preparing the next generation of faculty: Graduate school as socialization to the academic career. *The Journal of Higher Education*, *73*(1), 94–122. https://doi.org/10.1080/00221546.2002.11777132

Baker, V. L., & Lattuca, L. R. (2010). Developmental networks and learning: Toward an interdisciplinary perspective on identity development during doctoral study. *Studies in Higher Education*, *35*(7), 807-827. https://doi.org/10.1080/03075070903501887

Baker, V. L., & Pifer, M. J. (2011). The role of relationships in the transition from doctoral student to independent scholar. *Studies in Continuing Education*, *33*(1), 5–17. https://doi.org/10.1080/0158037X.2010.515569

Baker, V. L., & Pifer, M. J. (2014). Preparing for practice: Parallel processes of identity development in Stage 3 of doctoral education. *International Journal of Doctoral Studies*, *9*, 137–154. https://doi.org/10.28945/2041

Baker, V. L., Pifer, M. J., & Griffin, K. A. (2014). Mentor-protégé fit: Identifying and developing effective mentoring across identities in doctoral education. *International Journal for Researcher Development*, *5*(2), 83-98. https://doi.org/10.1108/IJRD-04-2014-0003

Boden, D., Borrego, M., & Newswander, L. K. (2011). Student socialization in interdisciplinary doctoral education. *Higher Education*, *62*(6), 741-755. https://doi.org/10.1007/s10734-011-9415-1

Bogdan, R., & Biklen, S. (2007). *Qualitative research for education: An introduction to theory and practice* (5th edition). Needham Heights, MA: Allyn and Bacon.

Borrego, M., Boden, D., & Newswander, L. K.(2014). Sustained change: Institutionalizing interdisciplinary graduate education. *The Journal of Higher Education*, *85*(6), 858–885. https://doi.org/10.1353/jhe.2014.0033

Borrego, M., & Cutler, S. (2010). Constructive alignment of interdisciplinary graduate curriculum in engineering and science: An analysis of successful IGERT proposals. *Journal of Engineering Education*, *99*(4), 355-369. https://doi.org/10.1002/j.2168-9830.2010.tb01068.x

Borrego, M., & Newswander, L. K. (2010). Definitions of interdisciplinary research: Toward graduate-level interdisciplinary learning outcomes. *The Review of Higher Education*, *34*(1), 61-84. https://doi.org/10.1353/rhe.2010.0006

Bourke, B. (2014). Positionality: Reflecting on the research process. *The Qualitative Report*, *19*(33), 1-9. Retrieved from https://nsuworks.nova.edu/tqr/vol19/iss33/3

Brister, E. (2016). Disciplinary capture and epistemological obstacles to interdisciplinary research: Lessons from central African conservation disputes. *Studies in History and Philosophy of Biological and Biomedical Sciences*, *56*, 82–91. https://doi.org/10.1016/j.shpsc.2015.11.001

Calatrava Moreno, M. D. C., & Danowitz, M. A. (2016). Becoming an interdisciplinary scientist: An analysis of students' experiences in three computer science doctoral programs. *Journal of Higher Education Policy and Management*, *38*(4), 448-464. https://doi.org/10.1080/1360080X.2016.1182670

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187-1218. https://doi.org/10.1002/tea.20237

Carey, M. A., & Asbury, J. E. (2016). *Focus group research* (1st ed.). New York, NY: Routledge. https://doi.org/10.4324/9781315428376

Carr, G., Loucks, D. P., & Blöschl, G. (2018). Gaining insight into interdisciplinary research and education programs: A framework for evaluation. *Research Policy*, *47*(1), 35-48. https://doi.org/10.1016/j.respol.2017.09.010

Corbin, J., & Strauss, A. (2014). *Basics of qualitative research* (4th ed.). Thousand Oaks, CA: Sage Publications.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5 ed.). Thousand Oaks, CA: Sage Publications.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory to Practice*, *39*(3), 124-130. https://doi.org/10.1207/s15430421tip3903_2

Creswell, J. W., & Poth, C. N. (2017). *Qualitative inquiry & research design: Choosing among five approaches* (4th ed.). Thousand Oaks, CA: Sage Publications.

Deo, M. D., & Griffin, K. A. (2011). More than friends: The social capital benefits of peer mentoring relationships in law school. *Ohio Northern University Law Review*, *38*, 306-332. Retrieved from https://heinonline.org/hol-cgi-bin/get_pdf.cgi?handle=hein.journals/onulr38&section=12

Dollarhide, C., Gibson, D. M., & Moss, J. M. (2013). Professional identity development of counselor education doctoral students. *Counselor Education and Supervision*, *52*(2), 137-150. https://doi.org/10.1002/j.1556-6978.2013.00034.x

Gamse, B. C., Espinosa, L. L., & Roy, R. (2013). *Essential competencies for interdisciplinary graduate training in IGERT*. Arlington, VA: National Science Foundation, Division of Research, Evaluation, and Communication, and Abt Associates, Inc. Retrieved from https://www.nsf.gov/ehr/Pubs/IGERT_Final_Eval_Report_2013.pdf

Gantogtokh, O., & Quinlan, K. M. (2017). Challenges of designing interdisciplinary postgraduate curricula: Case studies of interdisciplinary master's programmes at a research-intensive UK university. *Teaching in Higher Education*, *22*(5), 569–586. https://doi.org/10.1080/13562517.2016.1273211

Gardner, S. K., Jansujwicz, J., Hutchins, K., Cline, B., & Levesque, V. (2012). Interdisciplinary doctoral student socialization. *International Journal of Doctoral Studies*, *7*, 377-394. https://doi.org/10.28945/1743

Gardner, S. K., Jansujwicz, J. S., Hutchins, K., Cline, B., & Levesque, V. (2014). Socialization to interdisciplinarity: Faculty and student perspectives. *Higher Education*, *67*(3), 255-271. https://doi.org/10.1007/s10734-013-9648-2

Gardner, S. K., Szostak, R., & Repko, A. (2011). 'A Jack of all trades and a master of some of them': Successful students in interdisciplinary PhD programs. *Issues in Interdisciplinary Studies*, *29*, 84-111. Retrieved from http://our.oakland.edu/handle/10323/4465

Gee, J. P. (2000). Chapter 3: Identity as an analytic lens for research in education. *Review of Research in Education*, *25*(1), 99-125. https://doi.org/10.3102/0091732X025001099

Gelfand, M. J., & Jackson, J. C. (2016). From one mind to many: The emerging science of cultural norms. *Current Opinion in Psychology*, *8*, 175-181. https://doi.org/10.1016/j.copsyc.2015.11.002

Gonzales, L. D., & Rincones, R. (2012). Interdisciplinary scholars: Negotiating legitimacy at the core and from the margins. *Journal of Further and Higher Education*, *36*(4), 495–518. https://doi.org/10.1080/0309877X.2011.643772

Griffin, K. A., & Reddick, R. J. (2011). Surveillance and sacrifice: Gender differences in the mentoring patterns of Black professors at predominantly White research universities. *American Educational Research Journal*, *48*(5), 1032-1057. https://doi.org/10.3102/0002831211405025

Hazari, Z., Sadler, P. M., & Sonnert, G. (2013). The science identity of college students: Exploring the intersections of gender, race and ethnicity. *Journal of College Science Teaching*, *42*(5), 82-91. Retrieved from https://www.jstor.org/stable/43631586

Hirschy, A. S., Wilson, M. E., Liddell, D. L., Boyle, K. M., & Pasquesi, K. (2015). Socialization to student affairs: Early career experiences associated with professional identity development. *Journal of College Student Development*, *56*(8), 777-793. https://doi.org/10.1353/csd.2015.0087

Holley, K. A. (2009). Understanding interdisciplinary challenges and opportunities in higher education. *ASHE Higher Education Report*, *35*(2), 1–131. Retrieved from https://eric.ed.gov/?id=EJ850402

Holley, K. A. (2015). Doctoral education and the development of an interdisciplinary identity. *Innovations in Education and Teaching International*, *52*(6), 642–652. https://doi.org/10.1080/14703297.2013.847796

Hudson, T. D., Haley, K. J., Jaeger, A. J., Mitchall, A., Dinin, A., & Dunstan, S. B. (2018). Becoming a legitimate scientist: Science identity of postdocs in STEM fields. *The Review of Higher Education*, *41*, 607-639. https://doi.org/10.1353/rhe.2018.0027

Hurtado, S., & Sharkness, J. (2008). Scholarship is changing, and so must tenure review. *Academe*, *94*(5), 37–39. Retrieved from https://eric.ed.gov/?id=EJ814351

Inouye, K. S., & McAlpine, L. (2017). Developing scholarly identity: Variation in agentive responses to supervisor feedback. *Journal of University Teaching and Learning Practice*, *14*(2), 3-19. Retrieved from https://files.eric.ed.gov/fulltext/EJ1152016.pdf

Integrative Graduate Education and Research Traineeship Program (IGERT) (2011). *Program solicitation*. Retrieved from https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf11533

Jazvac-Martek, M. (2009). Oscillating role identities: The academic experiences of education doctoral students. *Innovations in Education and Teaching International*, *46*(3), 253-264. https://doi.org/10.1080/14703290903068862

Jeong, S., Litson, K., Blaney, J., & Feldon, D. F. (2019). Shifting gears: Characteristics and consequences of latent class transitions in doctoral socialization. *Research in Higher Education*, 1-27. https://doi.org/10.1007/s11162-019-09583-7

Johns Hopkins Center for Talented Youth. (2018, May/June). Discover the field of linguistics. *Imagine Magazine*, *25*(5), 28-30. Retrieved from https://cty.jhu.edu/imagine/docs/discover-linguistics.pdf

Klaassen, R. G. (2018). Interdisciplinary education: A case study. *European Journal of Engineering Education*, *43*, 842–859. https://doi.org/10.1080/03043797.2018.1442417

Language Science Center (2016, August 3). *Global research alliance in language*. College Park, MD: University of Maryland. Retrieved from https://languagescience.umd.edu/news/global-research-alliance-language

Lattuca, L. R. (2001). *Creating interdisciplinarity: Interdisciplinary research and teaching among college and university faculty*. Nashville, TN: Vanderbilt University Press. Retrieved from https://eric.ed.gov/?id=ED462873

Lattuca, L. R. (2003). Creating interdisciplinarity: Grounded definitions from college and university faculty. *History of Intellectual Culture*, *3*(1), 1-20. Retrieved from https://pdfs.semanticscholar.org/e779/c39301ffb61e00efc01951339fd618187ac0.pdf

Lindvig, K. (2018). The implied PhD student of interdisciplinary research projects within monodisciplinary structures. *Higher Education Research & Development*, *37*(6), 1171–1185. https://doi.org/10.1080/07294360.2018.1474343

Lindvig, K., & Hillersdal, L. (2019). Strategically unclear? Organizing interdisciplinarity in an excellence program of interdisciplinary research in Denmark. *Minerva*, *57*(1), 23–46. https://doi.org/10.1007/s11024-018-9361-5

Luedke, C. L., Collom, G. D., McCoy, D. L., Lee-Johnson, J., & Winkle-Wagner, R. (2019). Connecting identity with research: Socializing students of color towards seeing themselves as scholars. *The Review of Higher Education*, *42*, 1527-1547. https://doi.org/10.1353/rhe.2019.0074

Lyall, C. (2019). *Being an interdisciplinary academic: How institutions shape university careers*. London, UK: Palgrave Macmillan. https://doi.org/10.1007/978-3-030-18659-3

MacLeod, M., & Nagatsu, M. (2018). What does interdisciplinarity look like in practice: Mapping interdisciplinarity and its limits in the environmental sciences. *Studies in History and Philosophy of Science Part A*, *67*, 74–84. https://doi.org/10.1016/j.shpsa.2018.01.001

Malkki, L. H. (2007). Tradition and improvisation in ethnographic field research. In A. Cerwonka & L. H. Malkki (Eds.), *Improvising theory: Process and temporality in ethnographic fieldwork* (pp. 162–187). Chicago, IL: University of Chicago Press. Retrieved from http://www.worldpece.org/sites/default/files/artifacts/media/pdf/2007_cerwonka_malkki_improvising_theory.pdf

Maxwell, J. A. (2012). *A realist approach for qualitative research*. Thousand Oaks, CA: Sage Publications.

McAlpine, L., Amundsen, C., & Turner, G. (2014). Identity-trajectory: Reframing early career academic experience. *British Educational Research Journal*, *40*, 952-969. https://doi.org/10.1002/berj.3123

Merriam, S. (1998). *Qualitative research and case study applications in education* (2nd ed.). San Francisco, CA: Jossey-Bass.

Müller, R., & Kaltenbrunner, W. (2019). Re-disciplining academic careers? Interdisciplinary practice and career development in a Swedish environmental sciences research center. *Minerva*, *57*(4), 479-499. https://doi.org/10.1007/s11024-019-09373-6

National Academy of Science, Engineering, and Medicine. (2018). *The integration of the humanities and arts with sciences, engineering, and medicine in higher education: Branches from the same tree.* Washington, DC: The National Academies Press. https://doi.org/10.17226/24988

National Science Foundation. (n.d.). *National Science Foundation Research Traineeship (NRT) Program.* Retrieved from https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505015

Newswander, L. K., & Borrego, M. (2009). Engagement in two interdisciplinary graduate programs. *Higher Education*, *58*(4), 551-562. https://doi.org/10.1007/s10734-009-9215-z

Niehaus, E., & O'Meara, K. (2015). Invisible but essential: The role of professional networks in promoting faculty agency in career advancement. *Innovative Higher Education*, *40*(2), 159-171. https://doi.org/10.1007/s10755-014-9302-7

O'Meara, K. (2013). Advancing graduate student agency. *Higher Education in Review*, *10*, 1-10. Retrieved from http://www.higheredinreview.org/article-index/#TOC-Volume-10-2013-

O'Meara, K., Jaeger, A., Eliason, J., Grantham, A., Cowdery, K., Mitchall, A., & Zhang, K. (2014). By design: How departments influence graduate student agency in career advancement. *International Journal of Doctoral Studies*, *9*, 155-179. https://doi.org/10.28945/2048

Patton, M. Q. (2014). *Qualitative research and evaluation methods* (4th ed.). Thousand Oaks, CA: Sage Publications.

Perna, L. W., & Thomas, S. L. (2008). Theoretical perspectives on student success: Understanding the contributions of the disciplines. *ASHE Higher Education Report*, *34*(1), 1-87. https://doi.org/10.1002/aehe.v34:1

Posselt, J. R., Reyes, K. A., Slay, K. E., Kamimura, A., & Porter, K. B. (2017). Equity efforts as boundary work: How symbolic and social boundaries shape access and inclusion in graduate education. *Teachers College Record*, *119*(10), 1-38. Retrieved from https://www.tcrecord.org/Content.asp?ContentId=21903

Portnoi, L. M., Chlopecki, A. L. A., & Peregrina-Kretz, D. (2015). Expanding the doctoral student socialization framework: The central role of student agency. *The Journal of Faculty Development*, *29*(3), 5-16.

Robinson, T. N. (2016). *Exploring an Integrative Graduate Education Research Traineeship (IGERT): Using organizational culture to understand how programs work*. Doctoral Dissertation. College Park, MD: University of Maryland. Retrieved from http://drum.lib.umd.edu

Rossman, G. B., & Rallis, S. F. (2016). *Learning in the field: An introduction to qualitative research* (4th ed.). Thousand Oaks, CA: Sage Publications.

Rowe, J. W. (2008). Introduction: Approaching interdisciplinary research. In F. Kessel, P. L. Rosenfield, & N. B. Anderson (Eds.), *Interdisciplinary research: Case studies from health and social science* (pp. 3–9). New York, NY: Oxford University Press.

Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Schein, E. H. (1984). Coming to a new awareness of organizational culture. *Sloan Management Review*, 25(2), 3-16. Retrieved from https://sloanreview.mit.edu/article/coming-to-a-new-awareness-of-organizational-culture/

Sweitzer, V. (2009). Towards a theory of doctoral student professional identity development: A developmental networks approach. *The Journal of Higher Education*, *80*(1), 1-33. https://doi.org/10.1080/00221546.2009.11772128

Thiry, H., Laursen, S. L., & Loshbaugh, H. G. (2015). "How do I get from here to there?" An examination of PhD science students' career preparation and decision making. *International Journal of Doctoral Studies*, *10*, 237-256. https://doi.org/10.28945/2280

Thoenig, J. C., & Paradeise, C. (2014). Organizational governance and the production of academic quality: Lessons from two top US research universities. *Minerva*, *52*(4), 381-417. https://doi.org/10.1007/s11024-014-9261-2

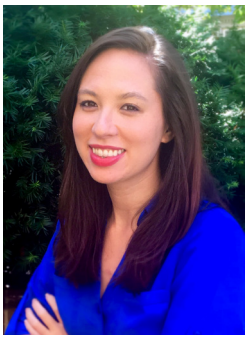
Thomas, D. R. (2017). Feedback from research participants: Are member checks useful in qualitative research? *Qualitative Research in Psychology*, *14*(1), 23-41. https://doi.org/10.1080/14780887.2016.1219435

Throne, R., & Bourke, B. (2019). Online research supervisor engagement: Fostering graduate student researcher positionality. In K. Walters, & P. Henry (Eds.), *Fostering multiple levels of engagement in higher education environments* (pp. 1-20). Hershey, PA: IGI Global. https://doi.org/10.4018/978-1-5225-7470-5.ch001

Twale, D. J., Weidman, J. C., & Bethea, K. (2016). Conceptualizing socialization of graduate students of color: Revisiting the Weidman-Twale-Stein Framework. *Western Journal of Black Studies*, *40*(2), 80-94. Retrieved from http://www.pitt.edu/~weidman/2016-ConceptSocGradStudColor.pdf

Yin, R. (2018). *Case study research: Design and methods* (6th ed.). Los Angeles, CA: Sage Publications.

BIOGRAPHIES



Dawn Culpepper is a doctoral candidate in higher education at the University of Maryland College Park. She studies equity, inclusion, and organizational change in faculty careers and graduate education and currently serves as a Faculty Specialist for the University of Maryland's ADVANCE Program.

KerryAnn O'Meara, PhD, is a Professor of Higher Education, Director of the ADVANCE Program at the University of Maryland College Park, Associate Dean in her college, and President (2019-2020) of the Association for the Study of Higher Education. Her research examines faculty careers, academic reward systems, and change strategies to support a diverse faculty and diverse forms of scholarship.

Amy Ramirez is a PhD student in the Higher Education program at the University of Maryland College Park. Her research examines graduate education, internationalization, and the academic profession, and seeks to identify strategies to produce knowledge that contributes to a more just world.