Preparing and Progressing: A Narrative Study of Optics and Photonics Graduate Students’ Identity-Trajectory

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Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy
In
Engineering Education

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September 9, 2013
Blacksburg, VA

Keywords: Identity, Narrative, Graduate Education

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ABSTRACT

Identity development, through time, of graduate students is a topic understudied in most disciplines, and completely unstudied in optics and photonics. As a physical science and engineering discipline with blossoming scientific value, optics and photonics is growing a small number of graduate programs. With this growth, a more in depth and detailed understanding of the exposure, recruitment, development and enrollment experiences of those students are needed. Identity-trajectory offers a promising theoretical framework to understand academic and professional development of professionals through time and has been shown to be reliable in many social science and humanities disciplines. The narrative methodology is emerging in use and acceptance within the engineering education research community. The provoking combination of a growing discipline, a theoretical framework with little prior application in physical science and engineering, with a creative methodology were intentionally selected for this study.

A semi-structured interview protocol was developed to prompt participants through a reflective description of their academic and professional development. Twenty-five current and recent graduate students from nine degree granting optics and photonics graduate programs participated in the study. In addition to participating in the interview, averaging about forty-five minutes, participants submitted a curriculum vita in advance of the interview. Both the interview and the vita provide the primary data used in this study. Interview transcripts were coded with the theory of identity-trajectory’s three strands: intellectual development, institutional influence and network.
The findings are grouped into pre-graduate training and graduate development experiences. Considering pre-graduate training, research experience as an undergraduate facilitates future decisions and access to graduate education. For graduate students, the structural experience within the graduate program, specifically related to research, facilitate progress through the program and beyond. The graduate program experience generally prepares students for academic research, but not the broader career pathways that students seek and eventually follow. All of these findings center on the laboratory, as the conduit for developing undergraduates to graduate students, and graduate students to professionals; the experience within the laboratory frames identity-trajectory throughout undergraduate and graduate experiences. These findings were used to provide strategies for departments, faculty and students in these fields, but are applicable in similarly structured disciplines.
ACKNOWLEDGEMENTS

Romans 8:28

Being called is a blessing. Thank you to my family: Daddy, Mommy, Jessica, and Whitney for supporting me, praying for me, being there and listening for all of these years of school. Daddy and Mommy, the way you raised me prepared me to reach for my highest heights. I’m glad and humbled to give you this recognition on paper that could never adequately capture what you have given me. To my extended family, I thank you for your many years of love and support. I love you all.

For my mentors, Dr. Camp and Dr. Mead, your support and influence have facilitated my progress and future contributions. Thank you. Dr. Borrego, you made this a reality – your willingness, patience, and advice have been invaluable. Dr. Watford, McNair, Cheville, and Richardson, thank you for taking the time to guide this work.

To my dear friends.... My engineering ed family: Stephanie Culter, James Pembridge, Dave Richter, and Brook Sattler - Thank you for being my wonderful peer mentors. You each have contributed to my development in some of the most meaningful ways. Your encouragement, advice, editing, commiserating, and friendship mean the world to me. The members of Club GLC - my Soror and big sister Keyana Ellis and brother Brian Moseley - “this ain’t no middle of the mall research!” Without you both I would not have made it this far –we did it! Thank you for the random study kidnapes, lots of coffee and Red Bull nights, and unforgettable memories. My Line Sisters, Keyasha, Chevon, Kacie, Julie, Takiyah, and Alicia - love and thank you. Anyone working on a doctorate degree and doing what we did is probably crazy, but the proof and value is in my relationship with each of you - 7 doctors! My NSU fam - CGS crew and 4009, thank you! Tenicka, Nicole, Donna, and Ashley - love and thank you all! NSBE family - Valerie, Sharon, Atina, Kirstin, and company thank you! Aaron, your support, encouragement, and push made this possible in the most difficult times – love and admire you.

This has been quite an experience! The testimony that has been shaped through each step, is for someone, and has a purpose.
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CHAPTER 1: INTRODUCTION

Optics and photonics as a discipline is rapidly becoming one of the most valuable assets to technology development although many people have never heard of it. Technological developments in optics have led directly to innovations in medicine, telecommunication, computing devices, and equipment for scientific research. In the United States, there are 14 institutions granting associate’s, bachelor’s, master’s, and/or doctorate degrees in photonics. Optics and photonics programs are situated within their institutions in various ways. Common sites for optics and photonics research and training in academia include departments of physics, electrical engineering, and materials science; however, the number of optics departments and research centers is increasing. Graduate students migrate into the field of optics in many different ways and through various interdisciplinary pathways. This study aims to understand professional identity development of graduate students in photonics-related departments through the three strands of identity-trajectory: intellectual, institutional, and network.

1.1 Need for this Research

Graduate student identity is a well-studied area of research but there is little work focused on engineering graduate students and none on photonics graduate students. Identity is an important aspect of many studies of STEM student retention, particularly at the undergraduate level. Formal training in optics usually does not coalesce until the graduate level, and that is the focus of this study. As members of a growing field within engineering, photonics faculty and program administrators will benefit from understanding the identity development of their graduate students, including these students’ prior experiences that have contributed to their decision to enroll. The
professional identity of an individual changes over time due to influences of past experiences, current aspirations, and future goals. Identity-trajectory theory uses three strands of identity that are not often combined in a single study: intellectual, network, and institutional (McAlpine, 2010). Lenses that are intellectual (individual contributions), network-based (connection to the academic field), and institutional (responsibilities and resources) contribute in varying ways to an individual’s professional identity construction. Identity-trajectory as a framework in this study will provide insight into the early experiences that lead to students’ selection of photonics, the influence of social-professional networks, and how their graduate institutions impact their future goals.

1.2 Purpose of the Study

The purpose of this study is to describe the identity-trajectory of graduate students in photonics-related graduate programs. Photonics graduate students come from multiple disciplinary backgrounds, which may or may not have included formal training in the field prior to entering their graduate programs. Understanding how students negotiate and construct their professional identity in this (interdisciplinary) environment provides insight for photonics programs in course sequencing, unconsidered pathways to the field for recruiting purposes, and professional development of graduate students.

1.3 Research Question

The central question in this study is:

How do photonics graduate students construct their professional identity?

Graduate school is one of the most formative professional periods for PhDs and should
be, to the extent possible, intentionally designed to foster the future success of graduates. The study aims to answer three sub-questions that contribute to better understanding career trajectories of photonics graduate students.

The sub-questions are:

How do past intellectual experiences contribute to the professional identity-trajectory of photonics graduate students?

How do networks and relationships influence the professional identity-trajectory of photonics graduate students?

How do institutional factors support or constrain photonics graduate students’ professional identity-trajectory?

The outcomes of this research may influence pedagogical practices and policies of these graduate programs to promote student success in ways that the program administrators may not have been able to uncover on their own. This research also contributes to identity-trajectory literature, especially in the context of graduate education. McAlpine and Lucas’s 2011 research focused on social science graduate students. Although there is also recent work including biological science students by McAlpine (2012), there has not been any identity-trajectory research published to date on engineering or physical science graduate students. This research contributes to the body of knowledge of graduate education in engineering and physical sciences, as well as identity-trajectory.

1.4 Overview of Methods

This study is an analysis of narratives of 25 optics and photonics graduate students in
PhD-granting programs. The study also includes a set of pilot interviews with department heads of departments of optics and photonics. Participants were purposefully selected to represent variation in institution, years in program, undergraduate background, work experience, gender, and nationality (Leydens, 2008; McAlpine, 2011). Two data sources were used for this study: interviews and curriculum vitae. Interviews were conducted with each of the participants to explore their identity-trajectory linking through their past, present, and future experiences. The findings focus on experiences, networks, and institutional factors and roles that contribute to how students saw themselves as professionals at the time of the interviews and their expected future careers. Curriculum vitae represent the students’ intellectual identity throughout their programs (McAlpine, 2010). These interviews and curriculum vitae were analyzed through open and axial coding methods to identify themes across the participants.

1.5 Limitations

One of the notable limitations of this study is that it focused on departments and PhD programs with optics or photonics in their titles. The relatively small number of specific degree-granting photonics and optics departments are at the forefront of the emerging field as its own disciplinary home. In a study on student and faculty interdisciplinary identities, McNair et al. argue that “traditionally the source of power is academic disciplines” (2011, p. 378); in the case of optics, the powerful departments are physics and electrical engineering. There is a substantially broader population in these departments of graduate students who affiliate with optics and photonics and those who intentionally develop their careers in this area could have been interesting participants; however, they were not included to reasonably limit the scope of this research.
1.6 Overview of Remaining Chapters

The remaining 5 chapters of this dissertation include (1) the literature review, overview, and theoretical framework; (2) methodology; (3) pre-graduate experiences; (4) graduate development; and (5) conclusion. Chapter 2 summarizes pilot research on photonics programs that contributed to the development of the study and reviews the literature relevant to the theoretical framework of identity-trajectory. Both the theory itself and its application in other studies of graduate students are reviewed. Chapter 3 describes in detail the methods developed and applied to this identity-trajectory study of optics graduate students. Chapter 4 presents findings on the pre-graduate training experiences of optics and photonics graduate students. These narratives demonstrate some of the most influential factors for preparing graduate students through the strands of intellectual, network, and institutional influences. Chapter 5 describes the graduate training and development of these students and the ways in which the three strands become a part of their development. Chapter 6 discusses the implications and conclusions of this research study.