Experiential Learning and Professional Identity Development for Scientists Participating in K-12 Outreach: A Case Study of the Graduate Extension Scholars Program

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ABSTRACT

To address 21st century environmental and economic issues, the practice of agricultural science has become more interdisciplinary, collaborative, and reliant on wider community connections. These changes have fueled demands to improve public agricultural literacy and strengthen the agricultural science workforce, increasing expectations for high-quality undergraduate teaching and public scholarship by agricultural science faculty. Unfortunately, faculty often lack professional preparation for this aspect of their work (Bagdonis & Dodd, 2010; Blickenstaff, Wolf, Falk, & Foltz, 2015). In other STEM fields, K-12 outreach by graduate students has gained popularity as a way to improve scientists’ skills and outlook toward public scholarship. This thesis explored learning and professional identity development for participants in a K-12 outreach program for graduate students in the College of Agricultural Sciences at Virginia Tech. The theoretical framework of Kolb’s (1984) experiential learning cycle and Lave and Wenger’s (1991) situated learning theory were employed to explore these processes.

Findings revealed that the Graduate Extension Scholars saw themselves as educators and public scholars both before and after participating in the program. Motivations for participation were related to identified gaps in their professional preparation. Participants believed that their knowledge, skill, and professional identity around teaching and public scholarship had been strengthened by their participation in the program. The program’s constructivist/experiential theoretical framework, community of practice, and extensive support structures were identified by participants as contributors to these outcomes. This study informs program evaluation and has broader implications for preparing future agricultural science faculty.
DEDICATION

This thesis is dedicated to my research participants, the pilot cohort of Virginia Tech’s Graduate Extension Scholars program, and their community partners. Thank you for welcoming me into your lives and being so open with your thoughts and experiences. Your passion for your work as scientists and educators rekindled my interest in pursuing a career as a science teacher, and for that I am eternally grateful.
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Though the work may have seemed isolating at times, the preparation of this thesis was by no means a “solo” endeavor. A number of individuals influenced or played a role in the completion of this research. First and fore-most I would like to thank faculty and staff of Virginia Tech’s university honors program, especially Christina McIntyre and Michael Blackwell, who supported my own professional identity development as a scientist and educator. I would also like to thank Dr. Erin L. Dolan, my undergraduate research advisor, and her colleague David Lally, who first introduced me to qualitative research and K-12 STEM outreach. Thanks also must be extended to Sarah Hanks, whose leadership as the program coordinator for the YMCA at Virginia Tech influenced my career trajectory into outreach education and on whose advice I applied for admission into the Department of Agricultural, Leadership, and Community Education. Within the department, I extend my sincere gratitude to Dr. James Anderson for arranging my financial support, Dr. Thomas Archibald for inspiring me to pursue an evaluation-related project. I also would like to thank Dr. Hannah Scherer for extending the opportunity to work with the GES program and for being such a thoughtful and attentive committee member. Thanks of course to my advisor, Dr. Matt Spindler for guiding me along the way while also giving me the freedom to chart my own intellectual path. Thanks also to Dr. George Glasson for serving as an external committee member and supporting this work as well as my transition into a teaching career. I am eternally grateful to my best friend Lucy Adams, my fiancé, Samuel Saulnier, and ALL of my fellow ALCE graduate students for providing moral support, advice, example work, and editing services throughout this process. Last but not least, I extend my sincere gratitude to the Graduate Extension pilot cohort and their community partners for welcoming me into their lives and allowing this research to happen. I quite literally could not have done this without you!
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1. **CHAPTER ONE: Introduction**

1.1. **Background**

   Education has long been seen as a vital key to individual, local, and national viability. In the 21\textsuperscript{st} century, many believe our nation faces pressing economic, environmental, energy and food security issues. As a result, there has been a call from politically significant groups to strengthen both formal and informal systems for science, technology, engineering, and mathematics (STEM) fields at all levels (National Academy of Sciences, 2007). These groups support STEM education reform and partnership programs to improve public scientific literacy and which aim to build a strong contingent of future STEM professionals. Agricultural advocacy groups see the agricultural sciences as a part of this evolving STEM workforce, and therefore promote agricultural education and outreach within the context of STEM education reform (Doerfert, 2011; National Academy of Sciences, 2009; Virginia Cooperative Extension, 2010).

   In response to these calls to improve STEM education and public STEM literacy, many major funders now require applicants to expand the substantive impact of their research by clearly defining the “broader impacts” of their efforts through education, outreach, or mentoring (Dolan, 2008; Dolan, Soots, Lemaux, Rhee, & Reiser, 2004; Lally, Brooks, Tax, & Dolan, 2007). One way to expose the public to cutting-edge scientific knowledge is through partnerships between K-12 schools or informal educational organizations and Institutions of Higher Education (IHEs) (Dolan, 2008; National Academy of Sciences, 2009). These outreach programs are seen as complementary to education reform measures that emphasize greater focus on the nature of science through authentic inquiry, and require well-trained educators versed in the scientific inquiry process (Achieve Incorporated, 2013; National Academy of Sciences, 2007, 2009; National Research Council, 1996; Partnership for 21st Century Skills, 2011).
The expanding “engagement imperative” has fueled significant growth in the prevalence of K-12 STEM outreach education efforts that seek to expose K-12 students to authentic scientific research and establish mentoring relationships between youth and scientific professionals (Buell, 2011; Siegel, 2010). The relative increase in the number and depth of STEM outreach initiatives is complementary to broader calls from associations of higher learning for land grant universities to “return to their roots” of public service, as originally expressed in the 1862 and 1890 Morrill Acts (Siegel, 2010; Talbert, 2007a). Through funded programs as well as volunteer initiatives, faculty and graduate students in STEM fields are increasingly becoming involved in outreach (Foster, Bergin, McKenna, Millard, Perez, Prival, Rainey, Sevian, VanderPutten, & Hamos, 2010; Pecen, Humston, & Yildiz, 2012; Stohlmann, Moore, McClelland, & Roehrig, 2011). STEM outreach activities can vary from providing resources at a distance or participating in single-day events to more involved collaborations such as teacher-scientist professional development workshops or co-created curricula and citizen science projects (Buell, 2011; Dolan, 2008). Figure 1, below, describes a continuum of involvement available to scientists seeking to conduct K-12 STEM outreach. The case of focus for this study is situated within the “strategic partnership” area of the spectrum, specifically combining the “scientist-in-the-classroom” approach with “outreach training for scientists.”

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1 See Appendix A for typical outreach formats and examples.
As scientists’ involvement in outreach expands, administrators and participants alike are realizing that communicating scientific research to non-specialists is an acquired skill (Dolan, 2008; Kim, 2007; Zhang, McInerney, & Frechtling, 2011). Engaging in outreach presents many challenges, including “culture clashes” between the K-12 and university settings around timing, pace, learning priorities, and working vocabularies (Dolan, 2008; Kezar, 2007). Many educators find their most significant challenge to be a lack of teaching and communication skills on the part of scientists. This challenge is exacerbated by the fact that explicit pedagogical training, to include understanding of quality pedagogy, is not usually a structured aspect of scientists’ professional preparation (Dolan, 2008; National Academy of Sciences, 2009; Zhang et al., 2011). In addition, professional pressures make it difficult for many scientists struggle to justify spending significant time on outreach activities (Brownell & Tanner, 2012). The myriad of challenges that beset outreach partnerships represent “boundaries” between the K-12 and university communities that disrupt the process of building the collaborations necessary to sustain outreach programming (Restine, 1996; Star & Griesemer, 1989).

Training programs to assist scientists in improving their teaching and communication skills have begun to emerge at universities. The goal of training programs that focus on teaching and communication is to improve the likelihood that participating scientists will be successful when facilitating K-12 STEM outreach and other community engagement activities (Besley, Dudo, & Storksdieck, 2015). In many cases, these programs target graduate students with the hope that early engagement will encourage pre-professional scientists to be committed to and skilled with K-12 collaboration and scientific communication in general (Burrows, Kukreti, Clinton, Cross,
Development of this skill, however, necessitates that graduate students learn what quality pedagogy looks like in the process of engaging in K-12 outreach. To scaffold graduate students’ experiences and enhance resultant learning, many programs embed ongoing training and mentoring into outreach activities conducted by graduate students (Collins, 2011; Crone, Dunwoody, Rediske, Ackerman, Zenner Petersen, & Yaros, 2011; Nilsen, 2013). This training supplements graduate students’ experiences with theoretical foundations and provides opportunities for them to reflect on and refine their teaching practice (Collins, 2011; Trautmann & Krasny, 2006)

1.2. Statement of the Problem

Promoting outreach at the graduate level is relevant in the agricultural sciences, given the complexity of global issues agricultural scientists are expected to address, such as global climate change, food security, and sustainable development of rural communities (Association of Public and Land-grant Universities, 2010; Doerfert, 2011; National Academy of Sciences, 2009). In order to address these issues, researchers and faculty in the agricultural sciences are frequently expected to work across disciplinary boundaries, communicate scientific expertise to the public, and teach in some capacity in addition to conducting research. In other words, they are expected to be “public scholars” (Bagdonis & Dodd, 2010). Furthermore, because cooperative extension services are housed or coupled within land-grant Colleges of Agriculture, faculty within these structures are likely held professionally accountable for public scholarship through full or partial extension appointments (Dolan, 2008; Fetsch, Holtzer, Johnson, Kendall, McDonald, & Newman, 2010).
Though most STEM fields have seen significant growth in opportunities for graduate students to become involved in outreach, these opportunities remain rare in the agricultural sciences (Bagdonis & Dodd, 2010; Kirwan & Seiler, 2005; National Academy of Sciences, 2009). Similar to their colleagues in the other STEM fields, faculty in the agricultural sciences typically receive little or no formal pedagogical training (Bagdonis & Dodd, 2010; Blickenstaff et al., 2015; Doerfert, 2011). The lack of outreach opportunities for graduate students in the agricultural sciences is therefore problematic for their professional development, given the high likelihood that they will be involved in outreach during their future careers (Fetsch et al., 2010; Lilley, DeBord, Hoban, Spears, Storm, & Watts, 1998). The lack of participation in outreach by agricultural science graduate students in comparison to graduate students in other STEM fields also puts K-12 agricultural educators at a disadvantage in terms of incorporating relevant current research into their programs (Scherer & Jamison, 2014). Expanding agricultural science graduate student training and involvement in outreach activities also has potential to alleviate these challenges, improving both formal and non-formal agricultural education at all levels.

However, outreach training programs for agricultural science based graduate students, and for STEM graduate students in general, are a relatively novel phenomenon. STEM outreach programs emerged in the literature in the late 1990’s with the formation of the NSF GK-12 and Math and Science Partnership programs. Since that time there has been virtually no documentation of agriculture-related programs of a similar nature. In order to effectively structure agricultural science outreach programs, there is a need to understand learners’ experiences within them. Additional research is needed to explicate the processes by which

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2This statement is based on the result of extensive searches of Virginia Tech’s Addison service, Google Scholar, and ProQuest using the keywords “K-12 science outreach” and “K-12 agricultural science outreach,” respectively. The former returned tens of thousands articles addressing STEM outreach since 1999, with a high level of relevance. The latter returned only a few thousand articles, most of which had a low level of relevance to the search terms.
graduate students learn during outreach training programs. Previous scholarship also indicates that research should include investigation of the program elements that are most impactful in the development of graduate students’ skills and identities as future public scholars while engaging in agricultural science outreach (Bagdonis & Dodd, 2010).

1.3. Setting

The Graduate Extension Scholars Program was founded in January 2015 and serves as the setting for this study. The program convenes a cohort of master’s and doctoral students in the agricultural sciences with three goal(s): (1) to increase graduate student capacity for engaging with stakeholders to develop high quality educational programs for youth; (2) to encourage partnerships between agricultural science research faculty, secondary schools, and communities; and (3) to expand youth awareness of and interest in career opportunities in the agricultural sciences (Scherer & Jamison, 2014). The program is managed by a program director and supported by a graduate research assistant. The author of this study served voluntarily as the graduate research assistant to the program for the pilot year.

The pilot semester of the program was funded by a Community Viability Grant awarded through the College of Agriculture and Life Sciences (CALS) at Virginia Tech. Its’ structure is loosely modeled on the Graduate Teaching Scholars program, which provides fellowship funding, training, and support for CALS graduate students interested in improving their teaching skills in the higher education setting. The program is informed by the College of Agriculture of Life Sciences’ strategic plan, which highlights the importance of working with local schools to enhance agricultural STEM education. It is also informed by the goals of Virginia Cooperative Extension, the National 4-H Council, the American Association of Agricultural Education, and

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3 See Section ‘E’ (p.11) for a list of definitions, including a description of the agricultural science and agricultural education terminology (i.e. 4-H, FFA, etc.)
the National Academy of Sciences to increase STEM interest and literacy among youth and to strengthen connections between current agricultural research and the K-12 Agriculture classroom (Doerfert, 2011; National 4-H Council, 2014a; National Academy of Sciences, 2009; Virginia Cooperative Extension, 2010).

Graduate student participants in the program, hereafter referred to as “Graduate Extension Scholars,” were paired with a Virginia Cooperative Extension Youth Development (4-H) Agent and a secondary-level school-based agricultural educator. The Graduate Extension Scholars were tasked with developing and delivering an educational module related to their research, which they piloted in their community partners’ classrooms and clubs. The Graduate Extension Scholars conducted between 3 and 5 site visits over the course of a semester to plan and deliver their modules. They were compensated for their time with a small supplement to their existing assistantship funding and with a stipend for lesson materials. At the conclusion of the program, the Graduate Extension Scholars refined their educational modules based on their partners’ feedback for publication via the program website.

During the program, Graduate Extension Scholars also received pedagogical training through a weekly seminar led by the program director. The program director utilized a peer-facilitation approach to seminar instruction. Via this approach, in addition to receiving instruction from the program director and guest speakers, the Graduate Extension Scholars independently researched pedagogical techniques and presented them to the group with the program director’s assistance. The seminar covered various pedagogical techniques promoted in both non-formal and school-based agricultural education settings, such as the Understanding by

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4 See “Definition of Terms” for clarification on the roles of these respective community partners.
5 A complete program budget can be found in Appendix C.
6 Though the majority of seminar activities are described here, a complete syllabus is provided in Appendix D.
Design framework and the 5E model for inquiry based learning. (Bybee, Taylor, Gardner, Van Scotter, Powell, Westbrook, & Landes, 2006; Wiggins & McTighe, 2005). A variety of expert guest lecturers from across the College of Agricultural and Life Sciences were invited throughout the semester to discuss topics relevant to the planning, delivery, and evaluation of outreach initiatives. There were also opportunities within the seminar schedule for the Graduate Extension Scholars to participate in group reflection on their experiences within their partnering communities. The program director also made herself available outside of the seminar to assist with module development. The research assistant additionally supported the Graduate Extension Scholars’ learning by assisting in seminar facilitation and by attending site visits whenever possible, providing feedback and facilitating pre- and post-reflection during those times. She also occasionally assisted them with module development by request.

1.4. Purpose of This Study

The purpose of this study was to explore the experiential learning and professional identity development processes that graduate students undertook while participating in the Graduate Extension Scholars program. Lave and Wenger’s (1991) situated learning theory was employed to describe the ways in which participation may have changed the way participants incorporated outreach into their professional identities. Specifically, this was observed through participants’ self-reported sense of commitment and perceptions of the purpose, appropriate methods, and target audience of agricultural science outreach by practicing agricultural scientists. This study also sought to identify changes in participants’ self-reported pedagogical, communicative, and collaborative competencies as well as program activities that may have been influential in supporting participants’ development of these competencies. Kolb’s (1984) experiential learning cycle was utilized to describe the process by which the Graduate Extension Scholars acquired
new knowledge and skills. This descriptive study is intended to augment existing scholarly literature on the development of the capacity of future faculty to engage in public scholarship (Bagdonis & Dodd, 2010). In addition, this study contributed to formative and summative evaluation of the Graduate Extension Scholars pilot and the literature on best practices in K-12 agricultural science outreach programming, in general. The theoretical framework for this study, including a description of Kolb’s (1984) and Lave and Wenger’s (1991) respective theories and the significance of public scholarship in agricultural education are described in more detail in Chapter Two.

1.5. Research Objectives & Questions

The overarching question driving this study was “How do agricultural science graduate students experience the outreach education training process?” Sub-questions pertaining to the overall question and purpose of this study included:

1) How do participants situate their outreach experience within the contexts of their professional identities and future goals?

2) What perceptions and skill or knowledge gaps do graduate student participants have about outreach education before and after participating in the GES program?

3) By what learning processes do participants modify their perceptions and overcome skill/knowledge gaps about outreach education as they progress through the program?

4) What significance do participants assign to the various social, pedagogical, and experiential components of the program (i.e. program community, program activities, and program structure) with regard to their learning and identity development?

Objectives and outcomes pertaining to the research question included:

1. Describe participants’ self-reported motivations for pursuing outreach education training.
2. Describe knowledge and skill outcomes of training as reported by participants.

3. Describe learning processes in which participants engage during their training.

4. Describe professional identity outcomes of training as reported by participants, specifically around commitment to outreach, sense of outreach as a professional responsibility, preferred methods, and perceptions of its purpose, target audience.

5. Describe structured program components to which participants assign particular significance for learning and professional identity development, if applicable.

An instrumental case-study design was employed to address these research questions and objectives, including a combination of interviews, field observations, and document review. Research methods are described in more detail in Chapter 3.

1.6. Limitations

This project is intended to be an in-depth case study of the experiences of a limited number of participants in the first iteration of a novel program unique to the College of Agriculture and Life Sciences at Virginia Tech. Therefore, caution should be taken against generalization of results with the intent of making broad statements about professional learning in the context of STEM outreach. Rather, readers are encouraged to use this information as a reflective tool when considering how they might structure similar outreach experiences for graduate students in STEM and agricultural fields. The preliminary findings from this study may inform future evaluation of the Graduate Extension Scholars program, to include quantitative or longitudinal research. As the program grows, longitudinal or quantitative studies may become possible, lending to increased generalizability (Creswell, 2007).

A further consideration of this study is the influence of the researcher’s role. As with any qualitative study, the researcher is ethically obligated to acknowledge his or her position within
the context of the study. As the research instrument, the self can never be fully removed (Creswell, 2007; Mertens & Wilson, 2012; Patton, 2002). In the case of this study, the researcher was uniquely positioned as a volunteer aid to the program director during the Spring of 2015 and as a paid research assistant focusing on the program’s evaluation during the summer of 2015. The researcher chose to position herself in this way for three reasons. (1) The researcher hoped to develop rapport with participants by attending and assisting with program activities. (2) The researcher hoped to contribute to formative evaluation as well as participants’ learning by framing interviews as reflective opportunities and by providing feedback to participants on their curriculum delivery during site visits. (3) The researcher desired to advance her own learning about program management, coordination, and evaluation. The researcher’s interactions with participants can therefore be seen as a contributing program component and her position can be referred to as that of a participant-observer. A detailed description of the researcher’s stance and the methods employed to maintain reflexivity during analysis can be found in Chapter 3.

1.7. Justification

Speaking to their growing popularity, studies of STEM outreach partnerships between research universities and K-12 science classrooms, museums, and science centers are common in the literature. There are numerous studies that describe “research science meets school science” programs in K-12 science classrooms, museums, and other formal or informal settings. However, in spite of the strong historic connections between land-grant agricultural colleges, the Cooperative Extension System, and the K-12 Agricultural Education system, outreach programs that specifically engage these groups in collaboration are not frequently documented.

Studies of STEM outreach training programs tend to focus on outcomes for K-12 students and teachers rather than outcomes for participating graduate students and STEM faculty
(Bruce, Bruce, Conrad, & Huang, 1997; Buell, 2011; Wellnitz et al., 2002). When they do address graduate students’ experiences with outreach, there is a tendency to emphasize end-of-program assessment of knowledge, skills, and attitudes (Burrows et al., 2009; Crone et al., 2011). Some process-oriented studies have focused on the teaching techniques and pedagogical orientations employed by graduate students in these programs (Christodoulou, Varelas, & Wenzel, 2009; Collins, 2011; Nilsen, 2013). A few investigate the professional identity development for graduate students in more detail (Buck, Leslie-Pelecky, Lu, Plano Clark, & Creswell, 2006; Montano, 2012).

Exploratory research that observes graduate students as legitimate peripheral participants in a community of public scholars has potential to inform effective practice for the preparation of future agricultural science faculty. Publicly-engaged agricultural scientists have the potential to influence public perceptions of the field and to contribute to improved science and agricultural education at all levels (Tanner & Allen, 2006). Investigating graduate students’ participation in outreach programs in both formal and informal agricultural education settings may additionally contribute to the improvement and expansion of such programs. In this thesis, constructivist and situated perspectives on experiential learning will be used to describe learning processes and professional identity of graduate students participating in K-12 agricultural science outreach and associated training (Fenwick, 2003; Kolb, 1984; Lave & Wenger, 1991). This study therefore has the potential to contribute to the literature on both graduate student development and agricultural science outreach.

1.8. Definition of Terms
The following terms will be used frequently throughout this thesis and will be therefore beneficial to define in advance for the benefit of the reader.
4-H. Stands for “hands, head, heart, and health,” the focus areas of the Extension Youth Development program, whose mission is to “empower youth to reach their full potential by working and learning in partnership with caring adults” (National 4-H Council, 2014a). 4-H programs consist of variety of out-of-school clubs and in-school enrichment activities managed by state Extension agents (Enfield, 2001; National 4-H Council, 2014a; Virginia 4-H, 2005).

SCHOOL-BASED AGRICULTURAL EDUCATION (SBAE). Refers specifically to agricultural education programs of study nested within secondary schools as part of the Career and Technical education program. Many SBAE programs feature leadership development through the National FFA Organization (National Association of Agricultural Educators, 2015).

APPRENTICESHIP. Apprenticeship refers to any complex system of work and learning in which learning is achieved through the “testing, building, revising, and integrating of schemas within the context of application” (Pratt, 1998, p. 86) in relationship with expert practitioners as well as fellow “newcomers” (Lave & Wenger, 1991).

BOUNDARY. Refers to divisions between societal sectors or communities of practice, demarcating differences in culture, area of work, or knowledge (Siegel, 2010, p. 26). Boundaries may exist between disciplines (i.e. between agricultural science and education) organizations (i.e. between higher education, school-based, and non-formal education organizations).

BOUNDARY WORKER. Also referred to in the literature as “brokers,” these individuals are strategically situated at the intersection of multiple communities of practice to communicate and translate across organizational, disciplinary, or cultural boundaries (Akkerman & Bakker, 2011; Bouwma-Gearhart, Perry, & Presley, 2014; Kimble, Grenier, & Goglio-Primard, 2010).

BOUNDARY OBJECT. The artifacts, documents, communication tools, or activities that assist collaborating parties or communities of practice in convening, translating, transferring information, or transforming practice (Akkerman & Bakker, 2011; Kimble et al., 2010).

COMMUNITY OF PRACTICE. Bailey (2013) defines communities of practice as “groups of people who share a concern or passion and deepen their knowledge through interaction.” Wenger (1998) designed this concept to describe the community that emerges from joint participation in professional practice. The predominant characteristic of a community of practice is sustained mutual engagement which creates relationships and norms unique to the community.

COOPERATIVE EXTENSION. Also referred to simply as “Extension,” this is a national system supporting research, education, public outreach in agriculture, natural resources, nutrition, health, leadership, community development, and youth development with the aim of “putting university knowledge into the hands of the people” (Virginia Cooperative Extension, 2015).

EDUCATION REFORM MOVEMENT. Starting with the 1983 report, A Nation at Risk and most recently manifested in the 2013 Next Generation Science Standards, the education reform movement seeks to establish standards for science education to improve the scientific literacy of U.S. students with the hope of improving the nation’s global competitiveness (Achieve Incorporated, 2013; Gardner, Larsen, & Baker, 1983; National Academy of Sciences, 2007).
EXPERIENTIAL LEARNING. The term is used to describe many and various learning activities that involve participation in authentic activities or field experiences, social interaction, and reflection on real-world experience (Hansen, 2000; Kolb, 1984).

EXTENSION AGENT – Administrative faculty employed by land-grant universities and located at various county offices or research centers throughout the state, specializing in one of the Cooperative Extension system’s three focus areas: Agriculture and Natural Resources, Family and Consumer Sciences, and Youth Development. In this study, “Extension Agent” will most often refer to the 4-H Youth Development agent (see “4-H”).

EXTENSION SPECIALIST – Tenure-track faculty located on the campuses of state land-grant universities holding some combination of Extension, teaching, and research appointments. They conduct research in their specialty area, but are also responsible for coordinating the efforts of county Extension agents working in a related focus areas (Fetsch et al., 2010; Lilley et al., 1998).

EXTENSION YOUTH DEVELOPMENT – See “4-H.”

FFA – The Future Farmers of America, now branded as the “FFA” serves as the pre-professional extra-curricular component of school-based agricultural education, supplementing classroom instruction with relevant extra-curricular opportunities. (National FFA Organization, 2014).

PROFESSIONAL IDENTITY –Describes how an individual sees oneself and one’s work in the context of one’s discipline, including one’s self-concept of adequacy in respect to expected values and behavior patterns (Brownell & Tanner, 2012; Trede, Macklin, & Bridges, 2012).

PUBLIC SCHOLARSHIP: - Referred to by Bagdonis and Dodd (2010) as “all aspects of the scholarship of application, including community engagement, Extension, and outreach scholarship,” (p. 100) public scholarship is the act of teaching, conducting research, or conducting outreach in a community-collaborative way that addresses public concerns.

INSTITUTION OF HIGHER EDUCATION (IHE): An educational institution that awards a bachelor’s degree (college/university), provides credit toward an associate’s or bachelor’s degree (community college), or not less than one year of training toward gainful employment (technical institute) (National Resource Center for Youth Development, 2015).

LAND GRANT UNIVERSITY – A system of IHE’s established by the 1862/1890 Morrill Acts and the 1994 Land Grant Act promoting “the liberal and practical education of the industrial classes in pursuits and professions of living” (Talbert, 2007, p. 36). They are characterized by a strong outreach mission and association with the Cooperative Extension system (Bagdonis & Dodd, 2010; Dolan, 2008).

LEGITIMATE PERIPHERAL PARTICIPATION – The social and cognitive learning that occurs as novices work alongside seasoned practitioners to acquire knowledge thorough increased responsibility and within a community of practice (Lave & Wenger, 1991; Pratt, 1998).
OUTREACH – “A systematic attempt to provide services beyond conventional limits” (Dolan, 2008, p.1). In the case of higher education, outreach extends the services of the university to the wider public, as is the case with Cooperative Extension or STEM outreach programming.

SITUATED LEARNING – “Learning in situations of application” (Pratt, 1998, p. 87), resulting in knowledge that is embedded in the context of its application, such as “on the job” training. This theory is associated with the apprenticeship model of adult learning, a form of experiential education (Fenwick, 2003; Pratt, 1998).

STEM – An acronym referring to “science, technology, engineering, and mathematics,” broadly used to describe fields relating to or requiring the application of these four disciplines. The agricultural sciences are considered a STEM field based on popular convention and the context of this study (National 4H Council, 2016).
2. CHAPTER TWO: Literature Review

2.1. Theoretical Framework

Graduate education draws heavily on an apprenticeship model of adult learning which views the graduate student experience as a process of professional socialization into academia (Austin, 2002). Entry into a professional community necessitates authentic experience with all aspects of future work, including research, teaching, and outreach in the case of university faculty (Austin, 2002). According to Wellnitz et al. (2002), speaking from their own experience as graduate students in the biological sciences, “Students should enter a graduate program knowing that part of what they ‘do’ is to communicate their understanding, interests, and discoveries to people outside science culture” (p. 561).

Pre-professional scientists are engaged in K-12 STEM outreach with the hope of instilling competencies such as collaboration, communication, and pedagogical expertise early in their careers. As Collins (2011) notes, we can reverse the experiential model upon which STEM outreach is based. If authentic, guided experience doing science serves K-12 students and teachers in developing scientific thinking, then the same type of experience with education should be helpful in preparing scientists to develop pedagogical thinking and program management expertise. However, just as in teaching science, this experience must be appropriately guided through advance preparation and training, goal setting, and ongoing reflection in the form of both expert feedback and self-reflection (Fenwick, 2003; Kolb, 1984).

Theories of experiential learning emphasize the critical role of experience in the construction of knowledge. The term is used to describe many and various learning activities that involve participation in hands-on activities or field experiences, learning through social interaction, and learning through participation in or reflection on everyday experience.
Experiential learning is often conceived of as cyclical or iterative process that balances a variety of observational, active, analytic, and reflective stimuli (Hansen, 2000; Kolb, 1984). Fenwick (2003) describes five prevailing theoretical orientations toward experiential learning; the constructivist, situated, psychoanalytic, critical cultural, and complexity theory perspectives.

Within the Graduate Extension Scholars program, graduate student participants or “Graduate Extension Scholars” are working on a “real world” problem – designing, developing, and delivering an educational module relevant to their research for K-12 students in two different settings; non-formal 4-H programs and school-based agricultural education. They also receive coaching and guidance from the program director, who has advanced training and professional experience as both an educator and a scientist. Over the course of a weekly seminar, they are exposed to various pedagogical approaches and theories of program management. They are given opportunities to construct their personal understanding of teaching and learning within the context of outreach through reflection on their module development and delivery experience as well as relevant prior experiences. Over the course of their experience, the Graduate Extension Scholars can therefore be considered to be engaging in Kolb’s (1984) experiential learning cycle. Their knowledge and skill acquisition can therefore be considered from the constructivist perspective on experiential learning, as described by Fenwick (2003).

In addition to teaching the Graduate Extension Scholars concrete skills applicable to the project at hand, this experiential learning process is intended to help the Graduate Extension Scholars prepare for future roles as agricultural scientists. In this role, they may be expected to engage in outreach and teaching in addition to research. Because the latter is likely to be more readily recognized toward professional accomplishment, their conception of teaching and outreach as part of a scientist’s professional identity must be robust (Brownell & Tanner, 2012).
They must be “public scholars” of the agricultural sciences, equally committed to communicating their science as conducting it (Bagdonis & Dodd, 2010). Over the course of their experience, the Graduate Extension Scholars are exposed to public scholarship through professional interactions with the program director, seminar guest speakers, and their community partners. According to Lave and Wenger’s (1991) situated learning theory, this identity is influenced by their interaction with these individuals. The Graduate Extension Scholars’ professional identity development thus lends itself to be viewed from Fenwick’s (2003) situated perspective on experiential learning.

Together, the constructivist and situated perspectives on adult experiential education form the theoretical framework for this study. The Graduate Extension Scholars’ experiences can be considered from either of these perspectives depending on whether one focuses on their knowledge/skill acquisition or professional identity development processes. In the sections that follow, these two major perspectives are reviewed before continuing with a more detailed discussion of the specific historical and theoretical contexts for graduate students’ participation in K-12 STEM outreach, including challenges, best practices, and practical applications of the constructivist and situated perspectives on experiential learning in graduate student development.

2.2. The Constructivist Perspective

As Fenwick (2003) notes, the constructivist perspective currently dominates experiential learning theory. In the constructivist perspective, learning is grounded in experience, sociocultural beliefs, and prior knowledge (Black, 2003; Klassen, 2006). From this perspective, knowledge is viewed as a set of mental constructs which can be represented, expressed, and transferred to new situations (Fenwick, 2003). Learning occurs through constant reflection on new experiences in the context of what was known before and how it was known. In other
words, individual learning is “contextualized” within the physical and social experience of daily life (Fenwick, 2003; Klassen, 2006).

The constructivist conception of experiential learning is based on the Dewey’s work, along with contemporaries Vygotsky, Lewin, and Piaget (Fenwick, 2003). These constructivists considered concrete experience to be the fundamental basis for learning in a continuous process of reflection, assimilation, and further observation to connect conflicting concrete and abstract conceptualizations of the world (Fenwick, 2003; Kolb, 1984). Abdulwahed and Nagy (2009) note that experiential learning can occur via application of knowledge in immediately relevant settings or through connection of daily life experience to abstract concepts. Regardless of the mode, the process is grounded in real-life experience and consists of a holistic combination of action, perception, cognition, and reflection (Fenwick, 2003; Kolb, 1984). The extent to which a learner is prepared for an experience will influence his or her ability to interpret and connect new learning to prior knowledge as well as to transfer or apply it in new contexts (Abdulwahed & Nagy, 2009; Fenwick, 2003). Before, during, and after an experience, learners are encouraged to reflect on the content, process, and premises - asking what happened, how, and why – and to consider their underlying assumptions about the phenomenon (Baker, Brown, Blackburn, & Robinson, 2014; Clark et al., 2010; Fenwick, 2003).

Dewey referred to the principle of “interaction and continuity” to describe the idea that learning process is inherently social, builds upon prior experience, and should provide a platform upon which to build through successive, structured experience connected to content (Dewey, 1986; Enfield, 2001). The iterative nature of learning is emphasized throughout the constructivist approach, but was particularly popularized by Kolb (1984). Clark et al. (2010) note that Kolb’s
experiential learning model is the one most commonly used in career and technical education, of which school-based agricultural education is a subset.

Kolb’s experiential learning cycle consists of continuous movement through four adaptive learning modes; concrete experience, reflective observation, abstract conceptualization, and active experimentation (Abdulwahed & Nagy, 2009; Clark et al., 2010; Kolb, 1984). Learning can begin at any stage and “knowledge results from the combination of grasping experience and transforming it.” (Kolb, 1984, p. 41). Knowledge is grasped through either conceptual interpretation and symbolic representation, referred to as “comprehension,” or through recognition of tangible immediate experience, referred to as “apprehension” (Kolb, 1984). Comprehension occurs through abstract conceptualization and apprehension occurs through concrete experience. Together, these two modes of knowledge acquisition form the “prehension” dimension of the learning cycle, which sets the stage for knowledge transformation (Abdulwahed & Nagy, 2009; Kolb, 1984). Transformation, or figurative representation of experience, occurs through internal reflection, also referred to as “intention,” or manipulation of the external world, also referred to as “extension.” The learning modes associated with intention and extension, respectively are reflective observation and active experimentation (Kolb, 1984). The transformation dimension can also be thought of as the dimension along which knowledge is constructed or applied (Abdulwahed & Nagy, 2009; Clark et al., 2010). The combination of these four modes of prehension and transformation results in four elementary forms of knowledge; divergent, assimilative, convergent, and accommodative (Kolb, 1984). A learner’s relative emphasis on each of these four modes of learning informs their learning style. An illustration of Kolb’s (1984) experiential learning cycle and resultant knowledge forms is provided in Figure 2, below.
It should be noted that the constructivist perspective strongly informs the pedagogical standpoint of most STEM outreach education efforts (Bruce et al., 1997; Burrows et al., 2009; Collins, 2011). It also strongly informs the philosophies of 4-H and K-12 Agricultural Education, who espouse “learning by doing” and “hands-on” learning in their respective programs (Carmichael, Nippolt, & Wang, 2010; Clark et al., 2010; Mowen & Harder, 2005; Phipps, Osborne, Dyer, & Ball, 2008; Virginia 4-H, 2005). Many STEM outreach programs, including those facilitated by 4-H, incorporate inquiry-based or problem-based approaches to learning science content – a modification of the experiential approach. Common to all of these approaches is the iterative flow among the stages of experience, exploration, conceptualization, and reflection, resulting in application (Clark et al., 2010). The role of the educator, from the
constructivist perspective, is to serve as a facilitator of each of these stages, but is especially critical in the reflective stage to help learners challenge assumptions and validate constructed knowledge (Fenwick, 2003).

In the context of the Graduate Extension Scholars program, participants are “learning by experience,” how to design and conduct outreach education. In keeping with the prevailing philosophy behind most outreach and agricultural education programs, the program has a strong focus on helping participants incorporate constructivist experiential approaches into their outreach activities. Seminar sessions created opportunities for abstract conceptualization of participants’ knowledge of teaching, learning, and outreach, as well as opportunities for reflection on prior and current experience. Site visits allowed participants to engage in reflective observation, followed by active experimentations with newly introduced pedagogical approaches. Therefore, given the presence of “interaction and continuity” in the Graduate Extension Scholars program structure, the constructivist perspective on experiential learning, particularly Kolb’s (1984) learning cycle, can be used as a model to describe the Graduate Extension Scholars’ learning experiences.

**2.3. The Situated Perspective**

Though the constructivist perspective can describe scholars’ knowledge and skill acquisition in some detail, it is limited in its’ ability to describe how scholars might incorporate this new knowledge and skill into their professional identities. Situated learning draws on the social constructivist school of thought, however, it also critiques the constructivist perspective for its emphasis on the individual learning process, resulting in a highly internalized view of learning (Engeström, Miettinen, & Punamäki-Gitai, 1999; Lave & Wenger, 1991). Informed by activity theory, situated learning extends the social constructivist perspective to include the ways in
which the learner’s “social world” affects learning, exemplified by the interaction between “newcomers” and “old-timers” in a community of practice (Lave & Wenger, 1991; Wenger, 1998).

Professional disciplines, such as the agricultural sciences, can be thought of as a type of “community of practice,” defined by Wenger (1998) as a group of people connected by mutual engagement in a joint enterprise moderated by common social norms and standards of practice. Individuals may simultaneously claim membership in multiple communities of practice defined by the different roles they play in their personal and professional lives (Wenger, 1998). Professional identity, as Brownell and Tanner (2012) conceptualize it, describes how an individual sees oneself and one’s work in the context of one’s discipline. Baruch and Cohen (2007) describe it as a subset of social identity or “the aspects of our self-concept we believe we have in common with others in the same group” (p. 247). These aspects include but are not limited to the professional activities in which we are engaged, the working relationships we have with other members of the professional community, and by formative events in our lives that led us to our career paths (Baruch & Cohen, 2007). Professional identity is also related to one’s self-concept of adequacy in respect to the values and behavior patterns expected of a member of a professional discipline (Trede et al., 2012). Wenger (1998) points out that identity within a community of practice is not limited to one’s self-concept, but must also be reflected in one’s “way of being in the world” (p. 151). That is, it is not sufficient to see oneself as having qualities in common with community members, but one must be actively engaged in the practice of community membership and recognized as such by others (Wenger, 1998).

In situated learning, novice members of a community of practice move toward full or “expert” membership, via “legitimate peripheral participation” (Lave & Wenger, 1991). In
legitimate peripheral participation, learners’ engagement in the community of practice is moderated according to their skill level and guided by more experienced practitioners. Lave and Wenger (1991) emphasize that, in legitimate peripheral participation, learning occurs through observation of and participation in the activities of the community as well as interaction with both experts and peers. The learner’s identity as a community member is legitimized through affirmation from experts and peers (Lave & Wenger, 1991). Membership is guided and symbolized, or reified, through the use of the community’s unique language or manner of discourse as well as the adoption of models and templates for practice unique to the community (Lave & Wenger, 1991). Over time, through successively more significant engagement in the practices of the community and through and social interaction with expert members, the participant not only begins to incorporate community membership into his or her self-concept, but also begins to act in accordance with the community’s norms, values, and standards of practice (Wenger, 1998). In the professional context, the learner begins to identify as a member of the professional organization or discipline in which they have been participating (Baruch & Cohen, 2007). As illustration of professional identity formation through legitimate peripheral participation is provided in Figure 3, below.

It should be noted that legitimate peripheral participation does not exclusively lead to full membership in a community of practice. Wenger (1998) describes three different “identity trajectories” a newcomer can take. An “inbound” trajectory occurs when a newcomer’s identity is invested in becoming a full community member and the learner is engaging in legitimate peripheral participation with the conscious intention of eventually becoming a full participant.
An example of an inbound identity trajectory would be a medical student engaging in residency with the intention of becoming a medical doctor. However, sometimes engagement in a particular community is truncated before full participation is achieved, either by choice or necessity. Even though the learner does not claim membership in the community, their access to the community and its practice was sufficient to contribute to their identity. For example, a medical school dropout will probably always identify to a certain extent with the medical community and may continue to apply the skills and values of a medical professional in future professional contexts. This is referred to as a “peripheral” identity trajectory. The third newcomer identity trajectory which Wenger (1998) describes is a “boundary” trajectory. In this case, the learner’s participation is motivated by a desire to link two communities of practice, both of which are significant to the learner’s identity. Sustaining identity across boundaries is referred to as “brokering” or “boundary work” and is essential to collaboration across disciplines.
In keeping with the previous examples, the hospital manager might serve as a broker between physicians, residents, nursing staff, and other professionals who fill different roles.

Situated learning is most commonly applied to the apprenticeship perspective on adult learning, according to Pratt (1998). Because the Graduate Extension Scholars program is loosely based on an apprenticeship model, situated learning is a particularly useful framework for the type of learning we can expect to see from participants. A fundamental assumption of the program is that outreach work cannot be learned outside of the context of practicing it, which is a fundamental tenet of situated learning (Lave & Wenger, 1991). Of the forms of apprenticeship described by Lave and Wenger (1991), the Graduate Extension Scholars program is most similar to the formal setting, in which group membership is acquired through a structured curriculum and purposeful mentorship. Some fundamental aspects of apprenticeship include increasing participation in the ongoing work of the community, a direct relevance of the learning setting to future work, and the predominance of practically focused, performance-related goals (Lave & Wenger, 1991).

In the context of the Graduate Extension Scholars Program, the participants are familiarized with the norms, values, and standards of practice of the agricultural education and STEM outreach education communities through a seminar curriculum that moves from a broad overview of the mission, roles, and history of 4-H, the FFA, and higher education community outreach in general, toward the specifics of planning and executing an outreach program with community partners. Through site visits, module planning sessions, and seminar guest discussions, the Graduate Extension Scholars interact professionally with practicing agricultural and outreach educators, planners, and evaluators. Their module development activities represent bounded participation in the activities of the agricultural education community.
The ultimate goal of the Graduate Extension Scholars program is not for participants to identify as agricultural educators – 4-H agents or school-based agriculture teachers – per se. However, as Master’s and Doctoral students in the agricultural sciences, each scholar is preparing for a career that involves educating others about agriculture in some way – be that as a professor, researcher, Extension agent, Extension specialist, or industry representative.

Agricultural education is informed at all levels by the 4-H and FFA programs, and public engagement is seen as an imperative of the land grant universities where most agricultural science departments are housed. Giving pre-professional agricultural scientists opportunities for legitimate peripheral participation in the agricultural education community may enable them to adopt a peripheral or boundary identity trajectory toward agricultural education, which has the potential to strengthen their position as public scholars.

2.4. The Need for Scientific and Agricultural Literacy in the 21st Century

The turn of the 21st century has been characterized by mounting calls for increased public literacy in science and agriculture as well as education reform to improve student outcomes and increase the future STEM and agriculture work-force. We are approaching the 30-year anniversary of the publication of “A Nation at Risk,” the first major public call for education reform since the Sputnik era. This report highlighted disappointing performances of U.S. youth and adults in areas of basic literacy, numeracy, and scientific understanding as compared to our global competitors (Gardner et al., 1983). This publication is criticized for spurring the rise of high stakes testing, but it also motivated the formation of the National Science Education Standards, which increased the emphasis on science as a process of inquiry as opposed to a process of memorizing a collection of facts (Buxton & Provenzo Jr, 2011; National Research Council, 1996).
The 2007 report “Rising above the Gathering Storm,” builds upon previous work around STEM education reform by highlighting the rising prevalence of European Union and Asian Pacific Economic Cooperation nations in science and technology as well as growing trade imbalances, stagnating public funding for science, and the disappointing performance by American students as compared to students from other developed nations on national and international math and science performance assessments. In the 2005 National Assessment of Educational Progress (NEAP) science assessment, only 32% of 8th graders and only 18% of 12th graders scored at or above the “proficient” level. The performance of American 12th graders on the 1999 TIMSS and 2006 PISA were particularly discouraging (National Academy of Sciences, 2007). PISA averages for American 15 year-olds in 2012 were not measurably different than in previous years, which beg the question – if the U.S. spends 39% more per student than the average member nation in the Organization for Economic Co-operation and Development (OECD), the pool from which PISA scores are taken, why are our students consistently scoring at or below average? (Kelly, Nord, Jenkins, Chan, & Kastberg, 2013; National Center for Education Statistics, 2014).

Relative deficits at the K-12 level translate to the adult population. Though science literacy among American adults showed an increasing trend in 2007, with 28% of adults demonstrating basic science knowledge, a 2014 report from the National Science Foundation (NSF) indicated that science literacy had stabilized (Michigan State University, 2007; National Science Foundation, 2014). Though the majority of adults who responded to the 2012 NSF survey held positive views about science, many struggled to respond to elementary science questions, showed an incomplete understanding of the nature of scientific knowledge, and
showed declining interest in socio-scientific issues such as stem cell research, climate change, and environmental quality (National Science Foundation, 2014).

Interest in science careers is also a concern. Though it is widely recognized that the need for a highly-trained scientific workforce is on the rise, data presented in *Rising above the Gathering Storm* indicated that the number of undergraduate and graduate students enrolling in STEM fields had remained relatively stable over the last several decades, and was predicted to level off in the coming years (Bybee & Fuchs, 2006; National Academy of Sciences, 2007). Over the past decade, graduation rates in STEM have improved, but recruitment and retention – especially of women and minorities – remain a high priority for the field (Gonzalez & Kuenzi, 2012). The 21st century push for STEM education reform has resulted in the recent release of a new set of standards for science education. The *Next Generation Science Standards* incorporate increased emphasis on engineering design and the relevance of science to social issues, thus increasing the relevance of the applied sciences to in the hopes of preparing students for a wide variety of 21st century careers (Achieve Incorporated, 2013).

The rhetoric in the agricultural sector mirrors that of the science community, with a rising call to integrate STEM competencies into the K-12 career and technical agriculture classroom (Myers & Washburn, 2008; Spindler & Greiman, 2013; Warnick, Thompson, & Gummer, 2004). Like *Rising above the Gathering Storm*, the 2009 National Academy of Sciences report, *Transforming Agricultural Education for a Changing World*, emphasizes the need to recruit students into the agricultural sciences, especially women and minorities. It highlights the need to integrate high-quality agricultural and STEM education to address critical challenges in the field – particularly the globalizing economy, the rise of “scientific agriculture,” and the increase in systems-based thinking to address pressing issues such as food security, climate change, and
environmental quality. However, with less than 20% of the U.S. population growing up in rural communities, agricultural literacy and workforce development is even more pressing an issue than science literacy and recruitment into STEM fields (National Academy of Sciences, 2009). In support of the Academy’s report, Kovar and Ball (2013) reviewed the research on agricultural literacy over the last 20 years and found that 17 out of 23 studies across a variety of populations identified deficiencies, the greatest of which were among K-12 students and teachers.

With the wealth of possibilities for application and experiential learning of STEM concepts, the K-12 agricultural classroom is increasingly seen as complimentary to the science classroom in advancing science literacy goals. (Myers & Washburn, 2008; Parr & Edwards, 2004). Common themes among reports outlining the need for science and agricultural literacy include (1) the complexity of current socio-scientific issues requiring 21st century professionals to possess the higher-order thinking and scientific reasoning skills to address them, (2) the prevalence of science, technology, and agriculture in daily life, demanding an appreciation for and understanding of these fields for informed citizenship, and (3) the importance of public and policy-maker understanding of science and agriculture to create a cadre of advocates to enhance public funding and political support for research and development (Crone et al., 2011; Doerfert, 2011).

Enhancing education at all levels is broadly embraced as a “systematic way” (Dolan, 2008) to address the issues of scientific and agricultural literacy, and is reflected in the most recent strategic plans of the Virginia Cooperative Extension System, the American Association of Agricultural Educators, among others (Doerfert, 2011; Virginia Cooperative Extension, 2010). Though training a capable STEM work force to secure the nation’s economic prominence is still a significant driving force behind for science literacy initiatives and education reform, the need
to build an informed, caring citizenry with the critical thinking skills to address 21st century socio-scientific issues is increasingly emerging as a motivating factor (McFarlane, 2013; Partnership for 21st Century Skills, 2011; Williams & Dollisso, 1998).

2.5. The STEM Education “Outreach Imperative”

The National Science Foundation responded to the call for increased science literacy by revising their grant proposal guidelines in 2000 to include “broader impacts” criterion; requiring NSF funded projects to indicate direct societal impact or to share discoveries with the wider public through “improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others” (NSF, 2013). Around this same time, the NSF initiated their two signature outreach projects - the GK-12 Fellowship program, which was founded in 1999 and the Math and Science Partnership (MSP) program, which funded its first projects in 2002. The former connects STEM graduate students with K-12 teachers to develop and deliver curriculum relevant to both the graduate students’ research and state learning standards. The latter connects scientists with teachers for a wide variety of projects; including “scientist-in-the-classroom” programs and professional development workshops for teachers by scientists (National Science Foundation, 2015a, 2015b). Though the GK-12 program was discontinued in 2012, existing projects were sustained through the 5 year grant cycle (Mervis, 2011). There is a significant body of research on the outcomes of both the GK-12 and MSP programs, much of which informed this study.

As mentioned in the introduction, the renewed push to connect the university to the public is not unique to the STEM fields, but spans all academic sectors (Cordeiro & Kolek, 1996;
Public forces that influenced this resurgence include the 1999 Kellogg Commission on the Future of State and Land-Grant Universities report, *Returning to our Roots: The Engaged Institution*, the American Association of State Colleges and Universities *Tools and Insights for Universities Called to Regional Stewardship* report published in 2006, and the 2007 Carnegie Community Engagement Classification System (Siegel, 2010). Notable discussions around this time included the *Committee on Institutional Cooperation* and the *National Forum on Higher Education for the Public Good* meetings in 2002 which resulted in an agenda to reduce the alienation between higher education and society (Bagdonis & Dodd, 2010). These discussions brought up the need to return to the original land-grant mission of service to the public, and created ranking and incentive systems to reward institutions for public service (Siegel, 2010). Sara Kindon, Rachel Pain, and Mike Kesby (2008) note that the role of university faculty is increasingly being re-envisioned from a one-way creator of knowledge to a working community partner engaged in two-way learning with professionals and citizens outside the institution.

Given that renewed calls for STEM education reform and public scholarship converged at the turn of the 21st century, the shift toward supporting higher education STEM outreach is not surprising. As a result, the past decade and a half has seen an explosion of STEM outreach and engagement projects across a variety of settings, from museums and nature centers to K-12 schools, universities, and national research laboratories (Buell, 2011; Foster et al., 2010; Montano, 2012). Dolan (2008) places outreach activities on a spectrum from “awareness” to “partnership,” and advocates for a high level of teacher involvement (i.e. partnership) to maximize benefits for all parties involved.7 Typical outreach formats include: “scientist in the

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7 For a review of Dolan’s (2008) outreach continuum, see Figure 1 (p. 2).
classroom” initiatives; technology programs, field trips, citizen science projects, summer science internships or camps, “Saturday science” programs, and teacher professional development. Because the Graduate Extension Scholars program falls into the category of “scientist in the classroom” partnership projects, the remainder of this literature review will focus primarily on findings from this type of project.

There are a variety of purposes for STEM outreach, but the most predominantly cited goal is to impact K-12 students’ understanding of and interest in science through “authentic” science learning (Bruce et al., 1997; Burrows et al., 2009). Predominant agendas for science outreach include the recruitment of the next generation into STEM fields and addressing public misconceptions about science (Besley et al., 2015; Bruce et al., 1997; Burrows et al., 2009; Pecen et al., 2012). Constructivist philosophy dominates the pedagogy of STEM outreach education, as the majority of programs emphasize “hands-on” or “inquiry-based” strategies for communicating scientific content, working from the standpoint that students learn best by experience (Bruce et al., 1997; Burrows et al., 2009; Collins, 2011). A secondary agenda for outreach, mentioned by Wellnitz et al. (2002) and Dolan (2008) is the obligation of universities to serve their communities. Broadly speaking, outreach presents a compelling way for land grant colleges to live up to their public service mission while assisting with the advancement of science education reform efforts and addressing public science literacy issues that are of concern to them as professionals (Crone et al., 2011; Kinpaisby, 2008; Montano, 2012).

In the realm of agriculture, science outreach has become a strong focus of the Cooperative Extension Youth Development (4-H) program, and some of 4-H’s national “signature” programs connect students to scientists vis à vis citizen science projects and science

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8 For an overview of outreach formats, see Appendix A.
fairs (National 4-H Council, 2014a; Virginia Cooperative Extension, 2010). There is also a need to assist school-based agricultural educators in effectively incorporating STEM competencies into their programs (Myers & Washburn, 2008; Spindler & Greiman, 2013). However, formal, funded programs that directly connect graduate students in the agricultural sciences to youth through partnerships such as GK-12 and Math and Science Partnership are rare in the literature, as compared to engineering, physical science, earth science, or biological science-based projects. Within Colleges of Agriculture, the majority of K-12 outreach activities tend to be concentrated within social science departments: agricultural education, leadership, communication, and economics (Bagdonis & Dodd, 2010). The apparent lack of “scientist-in-the-classroom” engagement in the agricultural sciences relative to other areas presents a significant missed opportunity for Colleges of Agriculture to capitalize on the “outreach imperative” in science education.

2.6. Successes and Challenges of Outreach

STEM outreach programs have shown measurable success in achieving their stated goals of improving science education (Bruce et al., 1997; Buell, 2011; Kirwan & Seiler, 2005). Particularly, Foster et al. (2010) and Zhang et al. (2011) evaluated the NSF-MSP program and found that science outreach activities by scientists improved teachers’ understanding of science content and processes in addition to their confidence in teaching science via inquiry-based methods. They also found that student achievement in science improved for classes involved in MSP sponsored programs. Generally, teachers are welcoming of the content expertise,

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9 A search of Virginia Tech’s library database of scholarly and peer reviewed sources for “science + graduate student + outreach” returned over 21,000 results, whereas the key words “agriculture + graduate students + outreach” returned less than 3,000. Relevance was significantly better in the former search than the latter, which only returned two directly-applicable articles (Jones, 1997; Rahman, 2006). A search of the NACTA journal returned two more (Gardiner, 1991; Kirwan & Seiler, 2005).
enthusiasm, and positive role-modeling that scientists bring into their classrooms (Bruce et al., 1997; Collins, 2011). Outreach also presents a singular opportunity for scientists to accrue new ideas about teaching and learning and to rekindle personal excitement about their own work (Dolan et al., 2004; Foster et al., 2010; Zhang et al., 2011). In their study of a teacher-scientist collaboration project, Munson, Martz, and Shimek (2013) extensively reviewed the literature on the benefits for both teachers and scientist of outreach projects and found similar results, a summary of which is provided in Appendix B.

The prevalence and success of many STEM outreach programs might lead one to believe that the process of connecting scientists to schools is simple. Because there is the common focus on education, the collaboration between universities and schools or non-formal educational institutions should be natural. However, regardless of the sector – even in relationships between collegiate-level departments of education and K-12 schools – differences in institutional culture can become a significant barrier (Bouwma-Gearhart et al., 2014; Dolan et al., 2004; Kezar, 2007; McMillan, 2011; Restine, 1996; Tsui & Law, 2007). Some of these cultural differences include the pace of school vs. university life; limitations to time and resources, and differing priorities for student learning. Restine (1996) also notes that there is often a wariness of the “academic elitism” sometimes portrayed by members of the higher education community. Differences in working vocabulary, noted by Dolan et al. (2004), serve as an additional barrier to STEM outreach efforts.

Indeed, simplifying the “language of science,” that is, using vocabulary and analogies that are accessible to lay-persons, is a frequently-cited challenge for scientists engaged in outreach work (Crone et al., 2011; Montano, 2012; Star & Griesemer, 1989; Zhang et al., 2011). This challenge is related to and complimented by frequent criticisms of the lack of pedagogical
expertise on the part of scientists (Christodoulou et al., 2009; Collins, 2011; Nilsen, 2013; Zhang et al., 2011). In addition, when conducting STEM outreach, scientists are often expected to engage students in inquiry-based learning, even though their training and home teaching style is most likely to be lecture-based (Doerfert, 2011; Dolan, 2008; National Academy of Sciences, 2009). It has become apparent that academics could benefit from increased knowledge of teaching and learning in order to be truly effective communicators to the public as well as exemplary instructors of budding scientists and the undergraduate and graduate level (Bouwma-Gearhart et al., 2014; Crone et al., 2011; Dolan et al., 2004).

A final barrier that presents itself to faculty getting involved with outreach is time. Amidst demands for high-quality research productivity and myriad other institutional responsibilities such as teaching, advising, and committee work, outreach may be seen as an “add on” to which faculty are unable to dedicate sufficient attention for success (Foster et al., 2010). Brownell and Tanner (2012) suggest that the reason outreach is deprioritized in this manner is because teaching and public engagement are not robust elements of most scientists’ professional identity. This de-prioritization is reinforced by the norms of the discipline, such as tenure and promotion policies that place a disproportionate emphasis on research productivity as compared to excellence in teaching or outreach and a lack of scholarly venues for scientists to showcase quality public scholarship (Brownell & Tanner, 2012). Outreach activities seem to be most successful when the participating faculty are (a) passionate about the cause and (b) well-supported by their institution (Dolan et al., 2004; Zhang et al., 2011). Changes in promotion and tenure policies to reward outreach activities are gaining popularity as a solution to this problem (Dolan, 2008; National Academy of Sciences, 2009)
Therefore, for STEM outreach activities to be successful, it is necessary for scientists to have sufficient training and support in order to negotiate the boundaries between the university and K-12 environments. Evaluators of outreach and partnership programs have identified two primary ways to achieve this support. Some institutions offer professional development workshops for scientists on the topics of communication, pedagogy, and outreach techniques either separately or in conjunction with outreach programs (Besley et al., 2015; Dolan et al., 2004; Foster et al., 2010). In addition, Dolan et al. (2004), Burrows et al. (2009), and Bouwma-Gearhart et al. (2014) emphasize the importance of resource professionals who are able to translate across both the theoretical and physical communities of education and science. These individuals are familiar with scientific culture and the process of science, but are also well-versed in education theory and practice. They also possess the interpersonal savvy to mediate between the two communities and create a productive, collaborative learning environment (Bouwma-Gearhart et al., 2014). Whether serving in a formal or informal capacity, the majority of partnerships rely on one or more of these “boundary workers.”

Zhang et al. (2011) describe the traits that make STEM faculty successful outreach partners. In addition to possessing “a high quality disciplinary background and credibility,” successful outreach faculty are also good instructors and are interested in how to teach more effectively. They are student-centered and believe in the goals of outreach changing the lives of students. In addition, they are open-minded to trying new approaches, and are willing to work in teams. Finally, successful STEM outreach faculty are able to “meet people where they are” in terms of content-level foundations, and are “in touch with their inner adolescent.” In short, successful outreach partnerships require STEM faculty to be supported by effective boundary workers or to be boundary workers, themselves. The question then presents itself – given the
growing demand for such programs, how do we produce more successful boundary workers to facilitate successful outreach projects?

2.7. Involving Graduate Students in Outreach: The Constructivist Perspective

The push for increased public engagement by universities has significant implications for the way beginning scientists at our colleges and universities are being trained (Siegel, 2010; Wellnitz et al., 2002). In response to this renewed interest in bringing the university to the public, some universities initiated changes in their promotion and tenure policies to reward quality teaching, outreach, and engagement in addition to research (Dolan, 2008; Foster et al., 2010; National Academy of Sciences, 2009). However, one of the major critiques of graduate education, today, is that students’ training emphasizes specialized research and technical skills while neglecting preparation in other faculty roles, such as teaching, advising, civic engagement, and public scholarship (Austin, 2002; Bagdonis & Dodd, 2010; Crone et al., 2011; Golde & Dore, 2001; Tanner & Allen, 2006).

Golde and Dore (2001) surveyed nearly 10,000 graduate students and found that the majority felt unprepared for the realities of future careers both within and outside of academia. As the result of a four-year qualitative study of graduate students’ socialization into the professoriate, Austin (2002) developed recommendations for more holistic graduate training. Some of these recommendations include proving opportunities to (1) develop deep knowledge and a personal philosophy of teaching and learning (2) learn about institutional service and public outreach (3) learn how to engage in interdisciplinary work or collaborate with partners outside of academia, and (4) learn how to communicate with the broader public. *Transforming Agricultural Education* echoes Austin’s (2002) recommendations, and others note that the issue

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10 Foster et al. (2010) mention the University of Texas and Dolan (2008) refers to the University of Arizona and the University of Wisconsin as examples of institutions that have modified promotion and tenure to reward outreach.
of graduate student training is just as pressing in the agricultural sciences as in any other field, if not more so (Bagdonis & Dodd, 2010; Doerfert, 2011; National Academy of Sciences, 2009).

Faculty participants and evaluators of STEM outreach initiatives recommend strongly that training in outreach begin at the graduate level (Munson et al., 2013). As such, this is a major goal of the GK-12 program and similar “scientist-in-the-classroom” initiatives that involve graduate students, to include the Graduate Extension Scholars program (Buck et al., 2006; Scherer & Jamison, 2014). When funded opportunities are not available, graduate students are increasingly taking advantage of volunteer opportunities to fill in the gaps in their formal training and prepare themselves to be effective educators and advocates as well as researchers (Foster et al., 2010; Montano, 2012). Engagement in outreach at the graduate level is therefore seen as a key piece to the puzzle for changing the culture of academia to better support outreach efforts and elevate the quality of undergraduate teaching (Burrows et al., 2009; Crone et al., 2011; Wellnitz et al., 2002).

Graduate students, however, face the same challenge as faculty in communicating science. Christodoulou et al. (2009); Crone et al. (2011), Collins (2011), and Nilsen (2013) found that graduate students struggled to simplify scientific language and effectively employ inquiry-based techniques in the K-12 setting. Given their training agenda, the majority of graduate-level STEM outreach programs are therefore highly-structured to provide support for learning and development of practice. In some programs, this consists of a pre-outreach training workshop (Collins, 2011; Montano, 2012). Other programs gather students for weekly or monthly planning meetings (Christodoulou et al., 2009; Wellnitz et al., 2002). Still others structure outreach activities and associated training as part of a formal, credit-bearing course or seminar via which faculty and guest speakers address the various aspects of education theory; from achievement
standards and pedagogical philosophies to lesson planning, assessment, and group management (Burrows et al., 2009; Christodoulou et al., 2009; Crone et al., 2011).

The basic premise behind structuring outreach programs in this way is to create a community of practice among graduate student participants and their faculty mentors around outreach education (Buck et al., 2006; Crone et al., 2011). Action is combined with opportunities for reflection based on Dewey’s perspective that “educative experiences… are imbued with anticipation, development, and unity” (Christodoulou et. al., 2009, p. 3). Workshops, seminars, or coursework provides a scaffold for the experience of conducting outreach, allowing participants to complete the experiential learning cycle (Crone et al., 2011; Kolb, 1984). Authentic experience designing, delivering, and evaluating outreach activities is a critical component, as is training and support. “Glossing over” one or the other has negative ramifications for the success of graduate student learning and the effectiveness of the outreach they conduct (Collins, 2011; Crone et al., 2011).

2.8. Involving Graduate Students in Outreach: The Situated Perspective

Graduate study can be viewed as a process of socialization into the communities of practice of various academic disciplines (Austin, 2002; Brown, Kirpal, & Rauner, 2007). In the context of the scientific community, and within academia in general, the community is by mutual engagement in the enterprise of knowledge generation. Membership and merit are closely tied to one’s status as a productive researcher. Heavy investment in teaching and public engagement activities is generally considered outside the “norm” of the community and goes against professional standards for merit. These “rules” for the practice of being an academic are formalized by institutional tenure and promotion policies as well as the standards for content acceptance into respected research journals, which offer limited opportunities to showcase
accomplishments in the realm of teaching and public outreach (Bouwma-Gearhart, 2012; Brownell & Tanner, 2012). However, as mentioned previously, modern expectations for the scientific endeavor have begun to expand societal expectations for academic scientists. In response, Bagdonis and Dodd (2010) call for the development of “public scholars,” for whom teaching and outreach, along with research, are essential community-defining activities. These individuals find ways to strike a balance between their roles and status as scientific researchers and educators, maintaining productivity in both areas and publishing in education and outreach related venues as well as their discipline-specific journals (Brownell & Tanner, 2012).

Graduate students’ participation in outreach programming can therefore be viewed as a “dialectic of practice,” by which they are obtaining a layered identity as educators and scientists which may in turn influence practice of the scientific community (Buck et al., 2006). Graduate students participating in outreach programs are not only seen as “scientists in training,” but as “outreach educators in training” and as potential change agents in the advancement of public scholarship by the scientific community. Many programs therefore aim to help graduate students incorporate outreach into their professional identities (Burrows et al., 2009; Crone et al., 2011; Montano, 2012; Wellnitz et al., 2002). Interacting with the educators and resource professionals who facilitate outreach programming may be a form of legitimate peripheral participation in the educational community which gives graduate students an opportunity to incorporate the social norms and values of this community into their professional identities. Montano (2012) found evidence for this in a case study of the “Portal to the Public” program, which paired STEM graduate students with museum educators to develop educational programming related to their field of study. Participants in this program developed a more positive outlook toward outreach and expressed an intention to be involved with similar programs in their future professional lives.
For students who identify with educators, but who feel alienated from that professional community due to their status as researchers, participation in K-12 outreach is an outlet for and affirmation of their burgeoning professional identities as “scientist-educators” (Buck et al., 2006; Tanner & Allen, 2006).

From the situated perspective, meaningful engagement with experts as well as fellow newcomers is critical to professional identity development, not to mention the acquisition of the practical skills necessary for expertise (Lave & Wenger, 1991; Pratt, 1998). Thus, social relationships are a critical component of the outreach training process. Workshops, meetings, courses, or seminar sessions give graduate student participants an opportunity to engage in the discourse of outreach education (Buck et al., 2006; Crone et al., 2011). Mentoring relationships that participants with community partners, program administrators, and faculty advisors provide access to outreach experts (Burrows et al., 2009; Montano, 2012). These relationships also reinforce values around the importance of outreach education.

The program community of practice described above can help mitigate challenges that graduate students often experience around adjusting to the K-12 culture, learning “how to teach,” figuring out how to make explicit links between their research and the K-12 curriculum, balancing personal and professional conflicts, and dealing with the pressure of keeping up with research responsibilities in the midst of the time commitment that outreach requires (Buck et al., 2006; Burrows et al., 2009). Advisor support and time constraints continue to be significant barriers that can be eased by funding, but not eliminated (Crone et al., 2011; Montano, 2012). Therefore, for the foreseeable future, outreach programs for graduate student scientists are likely to attract students who already see the value of outreach education, and who believe in this cause (Buck et al., 2006; Crone et al., 2011).
2.9. Benefits of Involving Graduate Students in Outreach

Even if providing training at the graduate level does not necessarily “win” new students over to outreach, it does create a supportive environment that may allow outreach-inclined scientists to increasingly persist in that work (Burrows et al., 2009; Montano, 2012). Such programs help graduate students understand the realities of teaching, planning, and working with stakeholders (Burrows et al., 2009; Crone et al., 2011). They also report enhanced time management skills, a helpful attribute to future faculty balancing a demanding lifestyle (Austin, 2002; Burrows et al., 2009). The majority of graduate students who participate in outreach programs report feeling better prepared to teach and more confident in their communication and evaluation skills (Burrows et al., 2009; Crone et al., 2011; Montano, 2012). Others express that their experiences with outreach encouraged them to bring more inquiry-based and hands-on techniques into the formal science classroom (Bruce et al., 1997). However, some note that the outreach environment is highly contextual and not entirely transferrable to undergraduate teaching (Buck et al., 2006).

In terms of benefits for K-12 educators and students, outreach programs that center on graduate students enjoy similarly positive reviews to those that engage professional scientists. Teachers value the enthusiasm and resources that graduate students bring into the classroom, extending the curriculum and enhancing science learning for students (Bruce et al., 1997). Graduate students serve as a ‘bridge’ of sorts between school-aged students and the scientific community. Not being far out of school, themselves, they often serve as effective role-models for younger students (Burrows et al., 2009; Collins, 2011). Placing emphasis on collaborative partnership with teachers, assessing and prioritizing their needs, and consistently evaluating and re-configuring outreach efforts enhances benefits to K-12 teachers and students while also
teaching graduate students about the iterative nature of program planning and design (Crone et al., 2011; Dolan, 2008; Dolan et al., 2004; Wellnitz et al., 2002).

Lastly, as mentioned previously, participating in outreach at the graduate level may strengthen their identity around public scholarship and increase graduate students’ likelihood to engage in outreach as future professionals. Scientists with outreach education experience are forming a new professional contingent who are helping to change the way in which the scientific community operates, serving as champions of higher education teaching reform and contributing to the growth of scientist-teacher partnerships for K-12 outreach (Dolan et al., 2004; Tanner & Allen, 2006). As Wenger (1998) notes, multi-membership or exposure to multiple communities of practice can result in an identity that lies at the boundary between them, helping the individual serve as a connector. By spanning the boundary between the scientific and educational communities, these individuals are serving as public scholars.

2.10. Conclusions and Implications for Agricultural Education

As evidenced by the literature from science education, engaging graduate students in outreach has significant potential for addressing national education-reform agendas at both the K-12 and higher education levels. When scientists are provided with sufficient support and training, they can serve as valuable partners in the enhancement of public scientific literacy and K-12 science education. However, the need to build bridges between the scientific and educational communities before engaging in outreach activities cannot be underestimated. Engaging scientists in outreach early in their career development has the potential to expand the “outreach contingent” and equip the scientific work force with individuals who are able to bridge those gaps.
Preparation of graduate students in outreach and engagement is relevant to the agricultural science community for numerous reasons. Given the expanding global population and prevailing struggles with climate change, environmental degradation, and rural community development, agricultural scientists are uniquely positioned as problem-solvers around food security, clean water, alternative energy, and natural resources management. Calls for K-12 education reform are “zeroing in” on the need to address socio-scientific issues, the majority of which have connections to the agricultural and life sciences (Achieve Incorporated, 2013; McFarlane, 2013). Increasingly, inter-departmental partnerships between K-12 science and agricultural education programs, as well as between K-12 science classrooms and informal programs like 4-H are seen as pathways for achieving science education goals (Myers & Washburn, 2008; Pellien, 2014; Warnick et al., 2004). Agricultural scientists are particularly qualified from a content standpoint to assist in such initiatives.

National agendas for agricultural education emphasize the importance of engaging agricultural professionals in public outreach to enhance public understanding of critical agriculture-related issues such as climate change, food security, energy security, community economic development, nutrition, and environmental stewardship. Effectively “getting the message out” has implications for public policy and the recruitment of the next generation of agricultural scientists (Doerfert, 2011). Because the K-12 school system provides the pipeline to higher education, programs targeting this population have the potential to play an important role in addressing these issues (National Academy of Sciences, 2009). Furthermore, by better integrating STEM content and understanding of the scientific process into agricultural curricula at the K-12 level, agriculture educators have the potential to simultaneously assist in addressing
national agendas for science education as well (Doerfert, 2011; Myers & Washburn, 2008; Warnick et al., 2004).

Up-to-date and STEM integrated curriculum requires that agricultural educators be in-touch with current research in the agricultural sciences (Doerfert, 2011). In this respect, as in the other STEM fields, engaging scientists in outreach has significant potential. Some programs that connect K-12 students and teachers with agricultural scientists exist, but they are not as prevalent as in other STEM fields. Indeed, it has been found that – similarly to in the other STEM fields – there is a significant lack of opportunity for agricultural scientists in-training to practice communicating with K-12 schools and the public, even though their future careers may require them to do so (Bagdonis & Dodd, 2010; National Academy of Sciences, 2009). Those agricultural outreach programs that do exist have shown success in enhancing science learning, as well as outreach competency on the part of participating agricultural science graduate and/or undergraduate students (Gardiner, 1991; Kirwan & Seiler, 2005; Smith, Prohn, Driscoll, Hesterberg, Bradley, & Grossman, 2014). Expanding opportunities for budding agricultural scientists is relevant to national agendas for agricultural education reform at all levels, promoting the American Association for Agricultural Educations’ priorities to enhance “meaningful, engaged, learning in all environments” and “efficient and effective agricultural education.” (Doerfert, 2011).

Understanding how graduate students learn and develop professional identities as legitimate peripheral participants in a dialectic community of practice could enhance the effectiveness and prevalence of outreach programs. More research in this area can help professionals in colleges of agriculture determine factors that motivate and support graduate students to engage in outreach, ingredients necessary to produce a quality outreach product that
is beneficial to the K-12 community, and produce deep learning on the part of graduate student about the art and science of teaching and public engagement. Drawing inspiration from the literature on outreach in other STEM fields can provide a model from which to base agricultural outreach efforts.
3. CHAPTER THREE: Methodology

As mentioned previously in Chapter One, the purpose of this study was to investigate the experience of agricultural science graduate students participating in a K-12 outreach education and professional development program. Specifically, this study sought to investigate the Graduate Extension Scholars’ learning process, professional identity development, and to identify aspects of the program structure that supported learning and professional identity development through constructivist and situated experiential learning. Research questions and objectives included:

1. How do participants situate their outreach experience within the contexts of their professional identities and future goals?

   1.1. Describe participants’ self-reported motivations for pursuing outreach education training.

   1.2. Describe professional identity outcomes of training as reported by participants, specifically around commitment to outreach and perceptions of its purpose, target audience, and preferred methods.

2. What perceptions and skill/knowledge gaps do graduate student participants have about outreach education before and after participating in the GES program?

   2.1. Describe knowledge, perception (of education/teaching), and skill outcomes of training as reported by participants.

3. By what processes do participants work through their perceptions and skill/knowledge gaps about outreach education as they progress through the program?

   3.1. Describe learning processes in which participants engage during their training.
4. What significance do participants assign to the various social, pedagogical, and experiential components of the program (i.e. program community, program activities, and program structure) with regard to their learning and identity development?

4.1. Describe structured program components to which participants assign particular significance for learning and professional identity development.

In this chapter, the qualitative design of this study is discussed in more detail, including the researcher position, study design, recruitment and data collection methods, and the data analysis approach. This study was fully approved by the Virginia Tech Institution Review Board for human subjects research and a copy of the IRB’s approval letter can be found in Appendix E.

3.1. Research Design

This study takes a qualitative approach to inquiry into the question of graduate students’ experiences, learning, and professional identity outcomes while participating in K-12 outreach. Ontologically, qualitative research supports multiple, subjective definitions of reality as lived by different participants. Epistemologically, knowledge in qualitative research is constructed, experiential, and co-created between researcher and participant through sustained close involvement. The values of both participant and the researcher are acknowledged in the context of qualitative research, and the participant voice is recognized through narrative writing and inductive analysis (Creswell, 2007; Mertens & Wilson, 2012). Trustworthiness in qualitative research is enhanced through a combination of activities which aim to improve the credibility, transferability, dependability, and confirmability of data. These activities include (1) prolonged engagement with and persistent observation of the phenomenon of interest, (2) triangulation of data vis-à-vis the use of multiple different data sources, data collection methods, investigators, or
theories, (3) detailed or “rich” description, (4) peer debriefing and inter-rater review, (5) 
member-checking, and (6) reflexive journaling by the researcher (Lincoln & Guba, 1985).

Specifically, a nested instrumental case study design was selected for this study on the 
basis that the Graduate Extension Scholars program represented the combined experiences of the 
four distinct participants. In an instrumental case study, the researcher selects an issue or concern 
as well as bounded case to illustrate that issue (Creswell, 2007). In the case of the Graduate 
Extension Scholars program the issue or concern is graduate students’ development as influenced 
by participation in an educational outreach and professional development program. As Patton 
(2002), further notes, “a single case study is likely to be made up of many smaller cases – the 
stories of specific individuals, families, organizational units, and other groups” (p.297).
Therefore, though the overall case consists of the program itself, the cases of the individual 
participants are nested within it as distinct cases. This nested design has implications for the 
analysis and presentation of results, which will first focus on the specific experiences of each 
participant, followed by thematic analysis across cases to draw conclusions about the program as 
a whole (Creswell, 2007; Miles, Huberman, & Saldana, 2014).

Further nesting and bounding of the case also occurs at the level of sampling, in terms of 
the activities and aspects of the case that are relevant to the research questions\textsuperscript{11} and observable 
within the constraints of time and means. Because the research questions for this study focused 
on the skill and identity development of the graduate student participants, the research activities 
were therefore bounded to emphasize their direct experience with outreach and associated 
training activities. Furthermore, though teachers, 4-H agents, program administrators, and K-12 

\textsuperscript{11} For research questions and objectives pertinent to this study, review section ‘e’ on page 11 of the introduction.
students were involved in the program in addition to graduate students, this study is focused exclusively on the graduate students’ experiences of interacting with these individuals.

Creswell (2007) emphasizes that in case study research, the researcher explores the bounded system over time through in-depth data collection involving multiple information sources. Furthermore, as mentioned previously, the use of multiple information sources contributes to triangulation, which lends credibility to the study findings (Lincoln & Guba, 1985). Therefore, data collection for this study consisted of three primary methods; interviewing, participant observation, and document review. A detailed description of data collection methods and efforts to establish trustworthiness for this study are provided in section (d).

3.2. Researcher Position

As the result of her prior professional experience as an outreach educator and service-learning program coordinator, the researcher places significant value in the land-grant mission to bring university knowledge to the public, in the effective training of educators at all levels, and in the sensitivity of outreach programs to the communities they serve. This belief in the value of outreach programs drives the researcher’s interest in their effective implementation and careful evaluation. These underlying values informed the researcher’s interest in the Graduate Extension Scholars program and the deeply involved methods via which this study was conducted. Specifically, pragmatism, constructivism, and a belief in the inseparability of personal values from the research process informed this study.

3.2.1. Pragmatism. The research questions for this study were informed by the researcher’s position as a pragmatic evaluator and constructivist educator. From the pragmatic perspective, research is informed by an emphasis on practicality and is structured to maximize usefulness of findings to potential stakeholders. The pragmatic researcher’s methodological
decisions are based on the purpose of the study as well as the conditions of the case or program under scrutiny (Mertens & Wilson, 2012). This research aims to have value to the staff and participants of Graduate Extension Scholars program. Therefore, though theoretical questions around situated learning were incorporated, the study is also in large part designed to evaluate the influence of the program structure on the participants’ experiences and learning outcomes.

One of the key aspects of pragmatism is the concept of methodological appropriateness. In a relatively new program such as the Graduate Extension Scholars, Trochim, Urban, Hargraves, Hebbard, Buckley, Archibald, Johnson, and Burgemaster (2012) note that evaluation should focus on implementation, process, and participant experience, all of which are appropriate topics for qualitative investigation. Furthermore, as Creswell (2007) notes, researchers use qualitative research when they desire detailed understanding of an issue, including its context and setting, or when they want to understand the unique perspectives of and interactions between individuals. These respective purposes for qualitative research relate directly to the research questions of this study, which pertain to the relationships of the Graduate Extension Scholars to one another, the other stakeholders in the program, their personal histories, and the norms of their professional communities as related to their outreach experience.

3.2.2 Constructivism. The emphasis on the experiential and social aspects of participants’ experiences is directly related to the researcher’s self-concept as a constructivist educator. In constructivist educational theory, learning is grounded in experience, social context, and prior knowledge (Black, 2003; Klassen, 2006). Knowledge is acquired through constant reflection on new experiences in the context of what was known, before (Fenwick, 2003). The role of the teacher is to help students’ acquire these skills as well as to build the conceptual “scaffold” necessary for students to make the leap of discovery between prior and new
knowledge (Black, 2003). Specifically, the constructivist research paradigm emphasizes meaning-making from the perspective of the participant, the influence of values, social and experiential basis of knowledge, and the influence of meaningful dialogue in research (Mertens & Wilson, 2012).

3.2.3. Values. Finally, the researcher’s approach to the design of this study is further influenced by her predisposition toward the values-branch of evaluation (Mertens & Wilson, 2012). Whereas some researchers take great pains to position themselves as a neutral observer in order to avoid undue influence on their participants, evaluators in the values branch and qualitative researchers in general reject the usefulness of this view (Lincoln & Guba, 1985; Mertens & Wilson, 2012). The values branch recognizes that it is not possible to eliminate the researcher’s values toward the phenomenon of interest, in this case outreach education (Mertens & Wilson, 2012). Instead, the evaluator prefers to openly and reflexively engage these values to empower and enhance participants’ learning. In this case, the researcher therefore positioned herself as a participant observer and reflective practitioner within this study, as do Crone et al. (2011). To a certain extent, the research activities are designed not only to collect credible data, but also to formatively guide participants’ learning through reflection and coaching. Therefore, the researcher’s presence is an integral aspect of the program’s structure and the researcher fully acknowledges her potential influence on participants’ learning.

3.3. Participant Selection & Recruitment

As mentioned in section ‘A,’ case-study sampling is bounded by the case under investigation. In the case of the Graduate Extension Scholars program, since it is a small, unique pilot program, the researcher had the opportunity to conduct comprehensive sampling, or examining every case in the given population (Patton, 2002). The subject pool for this study
consisted of four graduate students in the agricultural sciences who accepted the invitation to participate in Graduate Extension Scholars pilot program in the spring of 2015. Participants were selected for the program on the basis of their personal interest in the program and the recommendation of their advisor(s). Participants were recruited for this study in the context of one of their weekly seminar meetings, and were given equal opportunity to volunteer or decline participation in the study.

As briefly mentioned in the discussion of the study design, 4-H Extension Agents, K-12 agriculture teachers, and their students were also involved in the Graduate Extension Scholars program as participants module planning, site visits, and curriculum delivery activities conducted by the graduate students. However, these individuals were excluded from the sample on the basis that the study’s research questions pertain solely to the experiences of the graduate students. The program administrator, who conducted the weekly seminar, is also excluded from the sample population for this study. Rather, she served as a member of the research team for the purposes of evaluation and was be included in recordings of group meetings with her consent along with visiting lecturers and other guests who attend the seminar. Though the researcher was required by the IRB to obtain active consent from teachers, 4-H agents, students, or guest lecturers, these individuals were informed of the active study and given them the opportunity to review the study procedures, address any questions, and provide verbal consent to research activities occurring in their classrooms and/or program sites. Active, written consent procedures employed in recruiting graduate student participants and approving the program director’s participation in recorded meetings. A copy of the IRB approval for this study can be found in Appendix E.
3.4. Data Collection

As mentioned in the previous discussion of the study’s design, the three primary data collection strategies for this study included interviews, participant observation, and document review. The primary data collection method for this study was open-ended interviewing at the beginning, mid-point, and conclusion of the program. As Patton (2002) notes, “open-ended responses permit one to understand the world as seen by the respondents” (p. 21), which is a primary goal of this study. However, in order to obtain as rich a description as possible of the Graduate Extension Scholars’ experiences, an observational approach was also employed. Jorgensen (1989) notes that observation is useful for case-studies of newly-formed groups, when insider-outsider relations are involved, when the research problem is concerned with meaning and interaction from the insiders’ perspective, and when the setting is accessible to the researcher. Finally, document review served the researcher as a reference to the program’s conceptual framework, instructional plan, and schedule of activities, which consist of the program’s primary possible influences on learning. A discussion of procedures for data collection on a per-strategy basis follows.

3.4.1. Interviews. Interviews regarding participants' program experiences, professional identity, and beliefs about education were conducted in-person. The first interview was conducted within 1-2 weeks of the participant starting the program. The second interview occurred at the mid-way point of the program or after approximately 8-10 weeks of participation. Exit interviews were conducted after the program and associated dissemination activities, approximately 16-18 weeks after participants first entered the program. A semi-structured approach was employed for the instrument design so that interviews could follow the course of conversation (Patton, 2002). A pre-determined interview guide was employed to help maintain
the focus of the interview and to provide a template for note-taking, though additional questions did arise over the course of conversation. A copy of the semi-structured interview guide is provided in Appendix F.

Interviews were held in a private meeting room on Virginia Tech's campus that was conveniently located for participants. Every effort was made to schedule all three interviews in the same location, preferably the seminar classroom, to reduce environmental effects (Spindler, Personal Communication, January 16th, 2015). In addition to formal interviews, the researcher also initiated occasional “on the spot” exploratory interviews in response to ideas that participants brought up during site visits or seminar meetings. As recommended by Patton (2002), the protocol for these informal interviews was left completely unstructured as their occurrence was dependent upon opportunity in context.

**3.4.2. Participant Observation.** During the Graduate Extension Scholars’ weekly seminar meetings, semi-monthly site visits, and final curriculum delivery activities, the researcher conducted field observations of participants’ conversations, teaching activities, and reactions to interactions with peers, students, and community partners. The researcher’s note-taking structure was loosely based on the outline suggested by Creswell (2007), which entailed recording descriptive and reflective notes side-by-side, with details such as date, activity length, and setting indicated in a separate section of the notes. Due to schedule constraints, the researcher was not able to accompany the participants on all site visits, but she made an effort to accompany each scholar at least twice and was successful in doing so with all but one participant. The researcher was able to attend all but one of the 16 weekly seminar sessions. The primary purpose of observation was to establish prolonged involvement necessary to produce a detailed description of the program environment and to establish rapport with participants.
The secondary purpose was to triangulate participants’ self-reported attitude shifts and skill acquisition with observed language and behavior changes (Lincoln & Guba, 1985).

3.4.3. Participant Reflections. On occasions when the researcher was unable to accompany a participant on a site visit, the participant was provided with a reflection guide, with which he or she provided feedback on the visit. Participants were given the choice of responding to these reflection guides in writing or via self-recorded audio recording, according to their convenience. A copy of the researcher-generated participant reflection guide is provided in Appendix F, along with the interview guide.

3.4.4. Document Review. In addition to field observations and interviews, the researcher had access to the following documents: (1) a program description provided to each participant and community partner, (2) the weekly seminar syllabus and program timeline, (3) assigned reading and resource materials for the weekly seminar sessions, and (4) successive drafts of curriculum materials produced by the graduate. The primary purpose of document review was to give the researcher a sense of the conceptual framework and planned activities of the program so that she could relate these specific activities to experiences the participants referred to in interviews or informal conversations as particularly helpful or significant to their learning or professional identity development.

3.4.5. Audio recording. As is standard practice for interview research, all interviews were audio recorded and transcribed verbatim by the researcher for later analysis (Patton, 2002). Because the weekly seminar meetings were identified as a critical instructional and reflective activity, the researcher also chose to audio record them in addition to observing and taking field
notes. These audio recordings were selectively reviewed and transcribed during analysis to support themes identified in interviews and field notes.

3.4.6. Data management. In accordance with Virginia Tech IRB protocol, all audio and written data was stored in a locked filing cabinet or on a password protected computer only accessible to the researcher, with identified (audio, video, and consent forms) and de-identified (transcripts, documents, and field notes) data stored separately.

3.5. Data Analysis

The overall analytical approach to this study was loosely based on the constant comparative method described by Glaser and Strauss (1967). The researcher systematically reviewed and coded, or assigned meaningful labels, to segments of transcribed interview text relevant to the research questions. These codes were then grouped and compared to form categories. Both deductive and inductive analysis were used to formulate codes (Miles et al., 2014). Deductive codes connected participants’ statements or actions to existing concepts in the literature related to the study’s research questions. Inductive codes emerged from the data during the analytical process. These emergent codes described aspects of the participants’ experiences not previously noted in the literature or unique to the program. Throughout the process, codes were checked against emergent categories both within and across cases, and new codes and categories were formed or existing codes and categories were modified as interpretations were refined. Coding and category formation concluded when categories had achieved saturation and no new information could be gleaned from the data (Lincoln & Guba, 1985). The final code book for this study is provided in Appendix G. The Atlas.ti qualitative data analysis software platform was used to code transcripts and organize the coding scheme.
Though the analysis process was iterative, as described above, it was loosely divided into two cycles as recommended by Miles et al. (2014). The first cycle, focused primarily on creating descriptive codes to capture the various attributes, processes, emotions, values, and evaluative statements expressed by participants. Analytical memo was conducted throughout the first cycle to begin to identify patterns within and across cases and form preliminary categories. The second analytical cycle aimed to refine and organize codes into more general conceptual themes describing the broader relationships, explanations, and connections across cases. Case narratives were arranged according to these categories and were formulated at the conclusion of this cycle. Case narratives were then shared with the researcher’s advisor and the program director to check for inter-rater reliability of the emergent themes and results. Case narratives were also member-checked with participants to give them the opportunity to further refine the researcher’s interpretations of their quotes. Revision of categories and case narratives based on the inter-rater and member checks concluded the analytical process. The subsequent sections of this discussion describe the analytical cycle in detail.

3.5.1. First Cycle Analysis. As mentioned above, first cycle analysis was conducted with the aim of creating a consistent coding scheme. To connect observations of this program with prior research, the researcher began by generating of a-priori (or “before analysis”) codes from the research questions and the study’s literature review. These codes provided an outline of program elements for investigation and described success factors, outcomes, learning processes, and identity concepts described in prior studies. A-priori codes were entered into Atlas.ti for later use in the code scheme development. The remainder of the coding scheme was generated emergently from the interview data via a modified version of the open-coding method described by Patton (2002).
Once audio recordings of the interviews were transcribed, open coding began with close reading and analytic memo-ing. The researcher first read each transcript from start to finish to get a general sense of the data. Each transcript was then re-read, with the researcher pausing to memo at the conclusion of each topically distinct segment of text, hereafter referred to as an excerpt (Glaser & Strauss, 1967). Memos consisted of short statements or sentences summarizing the main idea, action, or reflective point the researcher felt was relevant to the excerpt and served as precursors to codes. Each memo was recorded on a 3” x 5” note card and labeled with the corresponding transcript date, participant pseudonym, page number, and line numbers of the excerpt from which it was formulated. Only a single idea was recorded on each note card.

Once each transcript had been reviewed in this manner, the researcher utilized the memo cards to formulate codes. Memos containing similar meaning and assigned a simple descriptive label consisting of a few words which was then recorded on a separate 3” x 5” note card. The primary purpose of this grouping and labeling was to develop consistent code names for excerpts across different transcripts that contained near-synonymous meaning. These labels formed the initial emergent codes. Once code names were developed, the code-bearing note cards were further grouped them into categories based on thematic meaning or process relationship. These categories were also assigned short descriptors which the researcher recorded on separately colored 3” x 5” note cards. These descriptors formulated initial emergent categories.

3.5.2. Second Cycle Analysis. Once an initial coding scheme was formed on note cards, emergent codes and categories were transferred into the existing a-priori Atlas.ti “code library” function to create a preliminary coding scheme (Patton, 2002). Emergent codes were compared with the a-priori codes already present in the library, and similar codes were combined. Once
codes were entered and redundancies removed, category descriptors were entered into the Atlas.ti “family library.” Codes were grouped into their respective themes using the “family manager” function.

After the initial coding scheme had been entered, the researcher then uploaded the interview transcripts into Atlas.ti and conducted a second round of semi-open coding based on the coding scheme that had been formed. This additional cycle of coding enabled the researcher to check the coding scheme for logical consistency with the data. Codes were refined or created as necessary during this process. New codes formed during semi-open coding were either sorted into existing families or formed the basis of new code families if they did not fit into any of the previously conceived categories. During semi-open coding, the researcher also constructed initial case narratives for each of the four participants, utilizing the codes and categories formed. Seminar recordings and field notes were also selectively referred to, transcribed, and coded at this time to provide additional evidence for the various themes identified. The final result of semi-open coding in Atlas.ti was a complete quote-book, in which codes were arranged into their corresponding categories along with the supporting evidence (quotes) from the data. The final quote-book was reviewed for clarity and consistency of codes and themes with the supporting data and was further refined or re-arranged as needed.

3.5.3. Strategies for strengthening credibility. As mentioned previously, various methods are employed during the analysis phase of the qualitative research process to credibility, which dovetails with dependability and confirmability in the establishment of trustworthiness in qualitative research (Lincoln & Guba, 1985). More credible analysis is achieved in this study through peer debriefing, triangulation by multiple researcher, and member checking.
Lincoln and Guba (1985) describe peer debriefing as “a process of exposing oneself to a disinterested peer in a manner paralleling an analytic session and for the purpose of exploring aspects of inquiry that might otherwise remain implicit within the inquirer’s mind” (p. 308). The process assists the researcher in clarifying interpretations, testing working hypotheses, developing next steps, and clearing his or her mind. Throughout the process of analytical design, coding scheme formation, and case narrative construction, the researcher relied on her advisor for peer debriefing. Periodic advising meetings in which the researcher explained her progress, process, and roadblocks to her advisor were the driving force of the analysis process.

Triangulation by multiple investigators was accomplished in this study by sharing the final coding scheme and case narratives the researcher’s advisor and the program director. The former served to affirm the consistency of the results with the raw data and the coding scheme developed during the peer debriefing process. The latter provided confirmation that the researcher’s observations were consistent with the reality of the program, given that the program director had also developed a close relationship with the Graduate Extension Scholars and was well aware of their learning process and major program outcomes, even though she had not formally collected data.

To perform member checks, the researcher provided each study participant with drafts of their respective individual case narratives and conducted one-on-one member-checking meetings with them to review the findings and further refine her interpretations of their quotes. As necessary, codes and categories were revised based on triangulation and member checks. These steps concluded the analytical process, summarized in Figure 4, below.
Figure 4: Analysis Scheme for Graduate Extension Scholars data
4. CHAPTER FOUR: Findings

In the chapter that follows, this study’s results for each participant are presented in case narrative form, followed by analysis of themes across their four cases. The case narratives herein comprise a combination of data obtained via a combination of participant observation and interviews and are arranged around the study’s research questions. As a review, the research questions included:

1) How do participants situate their outreach experience within the contexts of their professional identities and future goals?

2) What perceptions and skill/knowledge gaps do participants have about outreach education before and after participating in the GES program?

3) By what learning processes do participants modify their perceptions and overcome skill/knowledge gaps about outreach education as they progress through the program?

4) What significance do participants assign to the various social, pedagogical, and experiential components of the program (i.e. program community, program activities, and program structure) with regard to their learning and identity development?

Each case narrative begins with a biographical sketch, summary of key learning outcomes, and a summary of perception changes. Major themes around professional identity development, learning process, and key program components are then presented with supporting evidence from the data, in the form of quotes. The themes emerged from the study’s coding scheme, which is provided in Appendix G. The final section of this chapter describes the major cross-cutting themes that emerged across the four cases as related to the study’s research questions and theoretical framework. It should be noted that all place and person names referred
to in this and subsequent chapters are pseudonyms, with the exception of the program director, who declined the use of a false name.

4.1. Case Study - Hayden

4.1.1. Participant Biography. Hayden is a first year Ph.D. student in the department of Crop and Soil Environmental Sciences studying the implementation, management, and effectiveness of silvopasture\textsuperscript{12} forage systems for livestock production. His interest in the applied biological sciences stems from a life-long fascination with the natural world: “I knew a lot just from my own personal observations, taking notes and keeping field books since I was a little kid. But then getting into classes - that was a really interesting development for me - using evolutionary biology as a tool to understand not only what is happening, but WHY, and then how can we apply that understanding?” His interest in agriculture was also inspired by familial connections to farming.

Hayden had prior experience teaching in a variety of settings, including as a supplemental peer instructor in high school and as a graduate teaching assistant for several undergraduate agricultural science courses, including an experiential field course in agroforestry. He expressed an early inclination toward inquiry-based and experiential pedagogies in comments at the start of the program: “I am excited and I think that there are ways to involve students that can teach them a lot - not so much in the lecture setting, but through alternative means. So I’m excited about that.” Hayden’s career goals did not explicitly involve teaching, however, he recognized the importance of strong communication skills in a general sense, noting that “[as a scientist] you have to know how to communicate in a non-scientific way, as well.” To improve his

\textsuperscript{12} Silvopasture is the practice of combining forestry with grazing area for domestic animals in a mutually beneficial way that enhances soil protection and increases the producer’s long-term income due to the simultaneous production of wood or tree nut products and livestock.
communication skills, Hayden takes advantage of every available opportunity to participate in Extension activities with his advisor. He saw his participation in the Graduate Extension Scholars (GES) program as an extension of this training. Improving his ability to help non-scientists understand and engage with his work was a primary goal for Hayden.

For his module development project, Hayden was paired with a 4-H agent, Casey, and a veteran agriculture teacher, Peyton, in James County. The facilities at James County High School included a 30-acre school farm that focused primarily on beef cattle production. Hayden worked closely with Peyton and his students to assess the viability of implementing a silvopasture\textsuperscript{13} in a plot of pines adjacent to the school farm’s existing pastureland. He also helped the students and Peyton to perform the initial steps necessary to transform the stand into a working silvopasture, including expert consultation, basal area determination, selecting and marking trees for thinning, and sampling the soil to determine forage nutrient needs. Though Hayden did not provide direct programming to Casey’s 4-H clubs, he did invite Casey to observe his activities with Peyton’s students. During these observation visits, Casey and Hayden and discussed ways to modify Hayden’s activities to better suit the 4-H setting. Hayden made an effort to incorporate Casey’s suggestions into the written summary of his work which was published on the program’s website and which he presented at several conferences. In addition to working with Peyton and Casey, Hayden also invited the state forester\textsuperscript{14} and state forage agronomist\textsuperscript{15} to collaborate on the project, referring to them for advice and inviting them to participate in several instructional activities to fill in gaps in Hayden’s expertise.

\textsuperscript{13} Employed by the US Department of Forestry to oversee outreach and land management for a particular region
\textsuperscript{14} Employed by the US Department of Agriculture to oversee public outreach and land management for a particular region
\textsuperscript{15} Employed by the Natural Resource Conservation Service to oversee public outreach and land management for a particular region.
Key Learning Outcomes. As a result of his program experience, Hayden reported feeling more confident in his ability to communicate complex scientific concepts to non-expert audiences. In addition, he gained first-hand experience with silvopasture implementation and developed professional relationships with local natural resource professionals which he foresaw continuing beyond his GES experience. He also experienced the realities and limitations of program planning and implementation. Having struggled to strike a balance between Casey and Peyton’s program needs, Hayden came to understand the long-term effort required to effectively build relationships and implement programs. In addition, though he had been hoping to accrue a deeper understanding of the role of educational programs like 4-H and FFA in the agricultural industry, Hayden accepted that his short-term exposure was not sufficient to develop a nuanced understanding of their work.

Coming into the program, Hayden was primarily concerned with learning how to be a more engaging instructor. One of the skills Hayden reported acquiring was improved questioning techniques to facilitate class discussion “I’m still learning, but a WRONG question would be a dead-end question or a question that has so obvious an answer that students don’t really THINK. Whereas a GOOD question is something that makes them THINK. But you also want them to think along YOUR train of thought, so it’s about trying to find questions that are broad enough to encourage thought but also narrow enough so that you can keep students on the right track.” In addition, Hayden came to recognize that giving students responsibility in the form of concrete tasks also enhanced engagement “[in the future I would] give students more responsibility for doing calculations and solving real-world type problems instead of just regurgitating information.” However, Hayden also came to realize that engagement is strongly related to the instructor-student relationship “It may be that they warmed up to me and I warmed up to them –
but it did become more, engaged [over successive visits]. I think to engage students you’ve really
got to KNOW them and have a connection with them.” This realization represented an improved
understanding of the relational nature of teaching. Finally, Hayden reported an improved
understanding of how to write curriculum, which he felt increased his overall ability to write
about science in a way non-experts could understand.

**Key Perception Changes.** Though Hayden was inclined toward a more “hands-on” teaching
style before participating in the GES program, the program seemed to expand his perspective on
what teaching could look like. He also acquired several concrete pedagogical tools to use in
engaging and motivating learners, including knowledge of inquiry-based and problem-based
teaching methods. Upon discovery of these alternative methods, Hayden embraced an inquiry-
oriented model for teaching, not only in the classroom, but in the Extension setting, as well.
These new ideas for outreach and teaching helped Hayden to feel more confident that he had the
skills to meet high-quality “broader impacts” criterion for future research proposals. They also
gave Hayden a more positive outlook on teaching. Though he remained committed to his career
goal of becoming a researcher, he noted that he felt “more excited about it. If [teaching] is a part
of what I end up doing, I’ll just think about it more creatively. I think it’s a lot more fun to make
it hands on and to do it inquiry-based.”

Hayden also reported that his experience “increased my respect for teachers and the work
they go through and trying to engage students.” Experiencing curriculum development for
himself gave him a better understanding of the effort and expertise required to teach effectively.
“it takes me two weeks to get ready for one day [of teaching], you know? So how do [teachers]
take one evening?” This first-hand experience generated a sense of comradery and advocacy for
teachers, expanding his perspective on outreach as not only a professional development tool for
graduate students but for teachers, as well, noting that “we need to increase support for teachers and get more graduate students or professors to write curriculum [for them].” Ultimately Hayden came away from the program with an increased sense of commitment to and possibility for outreach programs like the Graduate Extension Scholars program. He became a program advocate, taking advantage of opportunities to present on his GES project beyond the requirements of the program. He did so not only to build his curriculum vitae, but because “I want to spread the word. I think it’s a great model. I’m excited about what Hannah’s doing and I want other people to get on board.”

4.1.2. Role of Outreach in Hayden’s Professional Identity. As noted previously, Hayden had a strong commitment to outreach and Extension prior to entering the program, which was further refined as a result of his experience. The following section describes the ways in which Hayden incorporated outreach into his professional identify, before, during, and after the program, in more detail.

As professional development. Hayden’s initial motivation for participating in the program was as an opportunity to practice communicating science. “Any opportunity to explain what I’m doing is really something I’m going to look for because I think communication is just so important to anything we do. No matter how good a scientist you are, you’ll never go anywhere if you can’t communicate what you’re doing.” Hayden understood that his professional success was directly correlated to his ability to articulate the basic concepts and importance of his research to non-experts, such as potential funders. Having observed his advisor, Hayden also understood that the only way to become more familiar and comfortable talking about his work was to practice as often as possible. Given that the Graduate Extension Scholars’ K-12 audience would have a near-complete lack of exposure to his research, the program presented a unique
opportunity for growth in his ability to communicate to individuals who “don’t have the scientific background to understand the jargon that I would normally use.” Hayden’s goal was to learn how to simplify his message while still making it meaningful.

Furthermore, Hayden was curious to learn more about the youth development side of agricultural Extension, noting “I’m interested in seeing how Extension works with schools, because I do think that’s an important link.” Because his prior experience was predominantly with adult Extension education, namely farmer development, he was excited about “the opportunity to work with the 4-H agent and teacher together” to “see that kind of collaboration.” The more practical exposure Hayden could get to the Extension system, the more prepared he felt he would be for his future responsibilities as an agricultural researcher, noting that “it just doesn’t make any sense to be working on applied science in the lab, and never have any interaction with the real world.”

As an extension of research. Though Hayden saw dissemination of research information as a part of his job, he also came into the program with an appreciation for the two-way flow of learning from practitioner to researcher, noting that “Even in applied science you can tend to get caught up in the work and forget about your connection to the world. So [outreach] is kind of a way for these university programs to disseminate information, but also to receive feedback about, what’s important in that area. It helps me to get a background view of why we’re doing this by connecting me to the [agricultural] community.” As Hayden continued with the program, he maintained that two-way outreach was a necessary component for research to be responsive to industry needs. However, he also came to appreciate the benefits that outreach could have for his research even at a basic level “I think it’s helped me a bit in thinking about science in general.
Talking about inquiry-based learning took me back to the basic principles of the scientific method, just a refresher of why we have controls and what we’re trying to figure out.”

**As a social responsibility.** While Hayden was committed to outreach for personal and professional reasons, he also saw social value in connecting with the public. Coming into the program, Hayden saw outreach predominantly as a professional responsibility to give the public access to new information and innovations that would improve the agricultural industry. As he interacted with students and educators, he also began to incorporate more youth development and educational reform themes into his discussions of the value of outreach. Ultimately, Hayden saw these areas of social contribution as related in their impact on community livelihoods, concluding that “I think the central goal of Extension is feedback between rural communities and agricultural scientists at the university level. We want to help them do a better job and make their WHOLE life, whether they’re farming or not, more sustainable economically and environmentally. It’s 100% the reason why I’m in research and why I’m doing what I’m doing. There’s no point in doing any of this if it’s not for the sake of improving our community.”

A key historic goal of Extension that is retained to this day is “taking knowledge gained through research and education and bringing it directly to the people to create positive changes” (National Institute of Food and Agriculture, 2015). From the start of the program, Hayden expressed a strong commitment to this goal. He saw K-12 outreach through the Graduate Extension Scholars program as a unique way to potentially address challenges with diffusion of innovation. “When [farmers] are busy in their careers they don’t want to come to another field day. It’s hard to approach them with new information. There’s kind of this back door that we have with high school students. Why not provide them with new, relevant, recent, information to get them interested and talking about it? That way not only will they think about it when they
take over the farm or start their own farm, but they’ll also go home and tell their parents about it and just pique the curiosity of whoever they talk to.” By updating and refreshing the material youth are exposed to, Hayden was hopeful that they could spread new research to the rest of the agricultural community.

As Hayden continued with the program, he began to discuss not only the spread of ideas and information, but the acquisition of new mindsets. “A lot of times farmers have the mindset of “well, this is the way I’ve always done it, so why should I change?” So, getting to the next generation and trying to get them to be naturally curious – that’s the value of inquiry-based learning. You’re trying to get them to think “How can I make this better? How can I improve?” Hayden recognized the value of critical thinking skills in contributing to the spread of new knowledge and ideas. Over the course of the program, he came to believe that inquiry-based pedagogy could enhance those attributes. Inquiry-based youth outreach, he explained, could further contribute to diffusion of innovation by fostering inquisitiveness among future members of the agricultural workforce. However, Hayden was also inspired to try this approach with adult education, noting that “Maybe we should change the way we do Extension in some way. Instead of just doing field days and presenting information, trying to structure it where we’re ASKING them questions and giving them a project for them to figure out for themselves. Trying to get them in the mindset of “I’m gonna set up controls and treatments and do research on my own farm to see what practice is best.”” Hayden expressed a hope that a more inquiry-based approach to Extension education, in general, would encourage farmers to be more willing to independently experiment and innovate as “citizen scientists.”

As Hayden progressed in the program, he began to talk more about the idea of getting students “excited and into science.” When asked in later interviews about his experience in the
program he noted the enjoyment he gleaned from piquing students’ curiosity and exposing them to concepts to which they probably normally would not have access. “I think it’s exciting to present new things to high schoolers and catch them at that age. These are very advanced and very NEW topics. This kind of thing probably won’t hit textbooks until probably ten or fifteen years from now. So, I think it’s great to start disseminating research to young students now.” A key value of the program, Hayden noted, was simply the student development aspect, “enabling them to learn new skills and new ways of doing things” for the sake of generating their curiosity and excitement for learning in general, regardless of the potential impact on farming practices.

Additionally, when asked to discuss the values of the program upon its conclusion, Hayden pointed out its value to teachers, noting that “they have a need to teach students about good agricultural practices and I think [silvopasture] is one of them. And [this program] is kind of a fun way for them to do it without too much effort. I think they haven’t put as much effort into it as they might put into a program that they developed [for themselves]. In fact, they might not have taught if we never worked together. But if they had to teach it – which I’m thinking it will probably become more a part of the curriculum in the future – then hopefully this helps.” As mentioned previously, being exposed to the realities of teaching increased Hayden’s appreciation for the potential of outreach programming to lighten teachers’ workloads and expand their scope of instruction, thus outlining an additional social contribution.

4.1.3. Hayden’s Learning Process. For Hayden, being immersed in a community of professional educators and natural resource professionals provided ample opportunity for interaction and observation. Instruction in the seminar exposed him to new pedagogical tools, but directed feedback from the researcher, program coordinator, his peers, and his advisor served to enhance Hayden’s ability to apply these tools to his curriculum design and teaching practice.
Ultimately, experiencing teaching for himself and then later reflecting on it in the process of writing his curriculum solidified Hayden’s understanding of inquiry-based pedagogy and how he might use it in the future. The various stages of Hayden’s learning cycle are presented in more detail, below.

**Instruction.** The foundation from which Hayden built his understanding of inquiry- and problem-based pedagogy was laid through instruction in the weekly Graduate Extension Scholars seminar. As Hayden notes, “the topics we’ve been talking about have really helped me see what I can do to better engagement students. So that’s been great because I would have known nothing about that sort of thing without it.” As Hayden noted previously, he had been interested in moving beyond the so-called traditional lecture model from the start of the program, but he was not well-versed in other techniques. Being exposed to specific pedagogical techniques though the seminar “gave me some practical direction.” As mentioned previously, Hayden particularly bought-in to the idea of inquiry-based learning. It should be noted that Hayden was assigned as a peer instructor for the session on inquiry, which meant he did extra reading and thinking about the topic in order to present it to his classmates.

**Interaction & Observation.** Another key way in which Hayden acknowledged learning was by simply immersing himself with experts in the field, observing and listening to them talk about their work. Speaking to his prior learning experiences, Hayden describes developing an understanding of the challenges associated with Extension, noting that he learned “probably not so much from firsthand experience, just, whenever Extensions gets together, that’s what we talked about.” Hayden’s approach to lesson design was similarly influenced by his observations of his partner teacher “He’s very practical, so that influenced me automatically away from lecture based teaching.” Furthermore, observing the ways in which the state forester and state
forage agronomist whom he had invited to assist with the project interacted with the students
gave Hayden additional ideas about student engagement. Specifically, Hayden noted that they
were very proactive about posing thoughtful questions about the proposed silvopasture site and
patiently encouraged students to try practicing with the equipment needed to mark and measure
trees. Hayden then attempted to mimic their approach in a subsequent soil sampling session.

**Experience.** Discussion-, problem-, and inquiry-based learning were relatively new
techniques for Hayden. However, the program coordinator gave the Graduate Extension Scholars
an opportunity to practice these techniques by facilitating a seminar session which Hayden noted
“was a little scary because I knew nothing about it. I’m used to presenting biology or chemistry
on a power-point. So to get there and try to have a discussion about something that you’re not
quite sure about yourself – that’s a little scary.” After initial success with his peers, applying this
approach to the high school setting brought up new questions “The students just weren’t
participating. So how do we change the format? How do we get other people to try to talk? I was
kind of just hoping that it would flow along naturally and it did, but probably the natural course
wasn’t the best course for best learning.” Over time, Hayden learned to give students more
concrete tasks and open-ended questions that stimulated discussion. This learning was in part
based on guidance from more expert educators but Hayden refined these techniques by slightly
modifying his approach to lesson delivery over successive classroom visits until he had achieved
the desired level of engagement.

**Feedback.** For initial lesson planning, Hayden relied on his peers’ and the program
coordinator to “provide great feedback and give creative ideas.” He noted that comparing his
own work to other Graduate Extension Scholars’ projects expanded the scope of possibilities for
methods of delivering the information. However, because his curriculum unit involved
consulting on a real-world project that the teacher and students would actually be implementing, Hayden was also concerned with the scientific accuracy of the information he was to be delivering. He therefore also sought content-related feedback from his advisor, the state forester, and the state forage agronomist whom he had involved in the project, noting that “They’ve been working in the field for much longer than I have. They bring different perspectives and help me to see what is and isn’t going to work in this setting.” Being highly concerned with providing a useful deliverable to his partner teacher, Hayden also frequently solicited feedback from Peyton with the aim of making sure his lesson plans were well-aligned with Peyton’s goals for the project and his overall approach to teaching.

When it came to refining his teaching technique, Hayden acknowledged timely feedback from the researcher, who accompanied him on several of his site visits, “I feel like YOUR comments after each visit were very helpful in helping me figure out what to do better. I think particularly asking questions was something I tried to change because YOU had said something about how I should ask more questions so I started to do that more.” Though not acknowledged in interviews, Hayden also received feedback on his lesson delivery from his partner teacher and 4-H agent, on occasions when she was able to join them. Hayden’s advisor also accompanied him on one of his visits, and provided instructional feedback which Hayden incorporated into future visits. Hayden also invited the state forester and forage agronomist to join him for several site visits, after which he solicited their feedback on his instruction, as well. The diversity of opinions Hayden sought on his performance was notable and unique among the four Graduate Extension Scholars.

**Modeling.** One of the challenges Hayden described in designing his curriculum was “not knowing what it was going to look like. Not having a group before me that I could see what had
already been done.” Of the four participants, Hayden most frequently expressed a desire for more concrete models to follow. He appreciated the program coordinator’s efforts to provide examples, noting that “It was nice when Hannah brought in her example module to see what that looked like.” However, there was intentionally little formal structure provided for curriculum design, to allow participants freedom to design something that satisfied their interests and the needs of their partners. In addition, there was no formal structure provided for the curriculum write up, though the Graduate Extension Scholars were directed to various website where they could find additional examples. Hayden therefore independently identified and relied on the 4-H curriculum template to organize his final product, which he described as follows; “They’ve got an inquiry-based lesson template where you can fill out the different boxes in their curriculum outline. So I just kind of followed that. It was really good to have that. I knew nothing about writing or how I should format it.”

**Reflection.** As Hayden progressed through the program and acquired new knowledge of pedagogical techniques, he became better able to reflect on his own performance and identify areas for improvement. Comparing later site visits to his initial ones, he noted that he “was able to see what I did wrong and what to apply. Whereas before I think I would have known something was “off” but I probably wouldn’t have had any solutions.” Feedback discussions with the researcher and community partners could be considered a form of reflection, as could interviews. However, one of the learning processes Hayden specifically reported as being most helpful for reflection was preparing written curriculum materials.

As a template for his write up, Hayden used a modified version of the “Understanding by Design” framework, used by 4-H (National 4-H Council, 2014b; Wiggins & McTighe, 2005). This framework emphasizes the importance of outlining “essential questions” and “enduring
understandings” related to the concept being taught. Reflecting on these ideas clarified Hayden’s own understanding of the science he was trying to communicate, which ultimately improved his ability to simplify the concepts for others’ benefit. As he noted, “A lot of these concepts are in my mind from different times I’ve used them. But often it’s just a jumbled mess. I can go out and DO it, but I can’t necessarily DESCRIBE it. I think sitting down and writing the curriculum gave me an opportunity to outline it all. So now that framework is in my mind and I feel like I have a better capability to describe it because it’s organized. So now I feel like I’m better equipped to communicate these topics.” In addition, the process of re-writing his initial lesson plans into a potentially publishable 4-H curriculum gave Hayden an opportunity to reflect on how he might have improved his lesson delivery. Because the 4-H curriculum template encourages the author to articulate classroom talk techniques and discussion questions, the writing process particularly assisted Hayden in reflecting upon the ways in which he could have better engaged students through questioning, possibly further contributing to his increased confidence in that area.

**Discourse.** A final way in which Hayden refined his ideas about teaching and learning was through discourse with his peers about the uses and usefulness of different pedagogical techniques, based on their respective experiences and the research they were uncovering in their seminar readings. As Hayden notes, “they’re all very sharp so it’s been great to hear their experiences. It helps me change the way I think about things and the way I might deliver information,” Hayden discussed how discourse with classmates broadened his perspective on educational issues, and the researcher observed that it also gave him practice conceptualizing and using academic ideas about education.

**4.1.4. Helpful program components for Hayden.** Several aspects of the program structure were integral to Hayden’s learning process. For example, as described above, the
seminar provided a delivery format for instruction as well as a venue for peer discourse. Site visits by the researcher/program assistant facilitated reflection on experience in the form of constructive feedback in addition to providing an opportunity to observe expert educators. Finally, the module development and delivery project, a critical program component, served as an avenue for experiential experimentation and practice applying the new skills he had learned. However, additional aspects of the program served Hayden’s learning in a broader sense by motivating, guiding, and supporting his learning process. Three central themes around the program structure which emerged from Hayden’s discussion of his experience are described below.

_A supportive community._ Throughout the course of the program, Hayden was surrounded by a community of learners and outreach practitioners with varying specialties and levels of expertise. These individuals, including his advisor (an Extension forage specialist), the program director (an Extension STEM education specialist), the researcher (an M.S. student in Extension education), his partner educators (an Extension 4-H agent and a school-based agriculture educator), local natural resource professionals (the USDA state forester and NRCS state forage agronomist) and his peers, were a consistent source of intellectual, emotional, and technical support for learning. Specifically, Hayden acknowledged his advisor, his partner educators, the researcher, and the program director for always being accessible and helpful. He also acknowledged his peers for being engaged, supportive, and encouraging of his work. Describing the atmosphere of the seminar, Hayden noted that “It’s been a good energy. Folks have been stimulated and they have been very participatory. I think people are excited to learn and I think because of that everybody IS learning and helping others.” This supportive environment
provided a safe space for Hayden to experiment with new ideas and teaching techniques, thus facilitating learning.

**Defined structures for accountability & technical support.** In addition to providing social support and encouragement, the community created by the weekly Graduate Extension Scholars seminar provided a structure of accountability to keep Hayden engaged in the program and continuing to participate fully. He described it as “a way to check-up and get feedback on the progress I’m making and also to kind of gauge it against the other students.” In addition to her accessibility outside of seminar, Hayden also appreciated the program director creating opportunities during the seminar to collaboratively work on aspects of the curriculum planning process “because that stuff has to be done any way, and it’s great to do it all together and work through it.” Furthermore, the program director provided deadlines by which the Graduate Extension Scholars were recommended to complete various aspects of the planning process, which Hayden also found motivating and helpful “If she didn’t [provide deadlines] I wouldn’t feel pressure. [My work] would be far delayed. So that’s why it’s great to have that pressure but I don’t think it’s too much pressure for me to be successful.”

**Financial Support.** Hayden was very frank in his admission that had the program not been associated with funding to cover supplies, travel, and a supplement to the Graduate Extension Scholars’ regular research funding, he would likely not have participated. His reasoning for this was that, in spite of the attractiveness of the program from a professional development standpoint, without some tangible incentive that would offset some of his research responsibilities, participation was not justifiable. He initially did not see the program as having significant research value, commenting that “If my interest, were to go into 4-H or high school education, then I could see how it would be worthwhile to do it and turn it into a research
opportunity that I could publish about.” However, Hayden did ultimately present a poster on his Graduate Extension Scholars project at a regional agronomy conference and toward the end of the program expressed an interest in pursuing an Extension publication of his curriculum materials. Ultimately, the financial incentive was the “hook” that enticed Hayden to commit to the program, after which his positive experience sustained motivation and overshadowed the initial financial motivator.

4.2. Case Study - Sidney

4.2.1. Participant Biography. Sidney is a first year M.S. student in the department of Horticulture studying grower perceptions of best management practices with the aim of developing clear recommendations for the state of Virginia. Her interest in Horticulture stems from her passionate hobby “I always loved growing things, even when I was a little kid.” Her interest in the GES program stemmed from her sociable nature “I like to work with people, so I know I’m going to like [working with the kids].” Sidney had prior experience working with youth as an undergraduate assistant to the university’s FFA summer enrichment programs, as well as some theoretical grounding in teaching and learning through her undergraduate course of study in horticultural education.

Sidney’s career goals revolve around teaching and Extension in the higher education setting “I’m interested in going on for a PhD. I like to teach and I wouldn’t mind being a professor. I [also] like to do the Extension side of Horticulture. [My department] thinks I would be a good Extension nursery crops person.” Because her research revolves around recommendations for growers, communication and outreach were already a significant component of Sidney’s professional identity before joining the program, “I want to write articles
and disseminate [my research], so growers can see that and I want to help to write Extension fact sheets to make it easy to understand for anybody.”

Sidney was paired with Kendall, a horticulture teacher in Newbern county, and Jordan, a 4-H agent in the city of Newbern. The curriculum unit she ultimately developed for Kendall’s class consisted of a growing challenge for students to explore the process of maximizing output while minimizing input, an essential goal of best management practice.

**Key Learning Outcomes.** For Sidney, the majority of new learning revolved around teaching practice, including lesson planning, pedagogical methodologies, and classroom management. In some cases, intuitive knowledge of effective teaching practice was affirmed “[during instruction] I felt like I was repeating myself a little bit. And I was surprised that after the fact the teacher told me that was really good. So I guess it sort of helped to drive the point home.” In other cases, new knowledge helped to frame practice “I learned how to organize the module because [previous to feedback] I hadn’t organized it in units. And I used the 5E’s as a way to organize it.”

Sidney also gained a deeper understanding of the roles and responsibilities of Extension agents and secondary agriculture educators. This included a recognition of the sometimes challenging nature of the 4-H agent’s work, as Sidney noted “[Jordan] was busier than we all thought [he would be],” but “it was nice to see that side [of Extension work].” Sidney also came to realize how collaborative teaching could be, “talking to teachers, I got more information about how they’re trying to use social connections to improve their own classrooms.” Lastly, Sidney learned to expect the unexpected when engaging in outreach work, noting that “seeing it in the classroom is totally different than having this beautiful plan on paper, because things
don’t always work out the way you expected. [For example], I was SHOCKED that somebody said “Can I use fish tank water in my plant?”

**Key Perception Changes.** In addition to learning new teaching techniques and acquiring a more accurate sense of the nature of teaching and Extension work, Sidney developed new ideas about the social context of educational practice “There’s a bigger social side [than I realized before]. Education isn’t just presenting the information. A lot of it is finding ways to connect with the other person.” As a result of her Graduate Extension Scholars training, Sidney reported an increased likelihood of using student-centered teaching strategies in the future. She also developed a more positive outlook toward collaboration, noting that “one of the things that I got out of it was the POWER of a GOOD group to be able to achieve some goal.” Sidney also reported an enhanced appreciation for the expertise and commitment of professional educators. “What I got from presenting at the teacher’s conference was that a LOT of the agriculture teachers are just plain awesome. What I was seeing in Kendall was NOT the exception.” Sidney’s experience raised new questions about working with people which she stated she would take forward into her future career. For example, in comparing the success her partner teacher had had with student behavior management using a student-centered, experiential teaching style, Sidney postulated whether a people-centric management approach could have the same effect on adults, noting “if you’re having problems with an employee. If you change your management style with that person will they clear up?” Ultimately, Sidney’s experience was an eye-opener into the relational nature of teaching and learning at all levels.

**4.2.2. Role of Outreach in Sidney’s Professional Identity.** As mentioned previously, Sidney had the most prior experience with agricultural education of any scholar and a clear interest in a profession revolving around teaching and outreach. Participation in the Graduate
Extension Scholars program for Sidney was a clear move toward her future career goals. The following section more specifically describes the ways in which the program was aligned with Sidney’s professional identity and ways in which she refined her conception of herself as an educator and outreach professional over the course of the program.

**As professional development.** For Sidney, outreach and education were a clear aspect of her career goals from the onset of the program. Given her extensive prior experience, education is a significant strand of Sidney’s work and she openly admitted her interest to her department “I was in the education option in my department [as an undergraduate] and that interest comes out a little bit even though I’m doing other things as well. So the department already knew that I was interested in Extension.” Indeed, it was a departmental administrator who had recommended Sidney for the program.

Given her goal of a career in Extension, Sidney is very conscious of taking every opportunity to expand her outreach resume, “the more the experience in a particular area you have, the more standing you have to discuss what you’ve done and your background.” In particular, Sidney wanted to build proficiency in teaching beyond what might be expected of her professionally. “I think that information on teaching and learning is going to help me be a better professor. A lot of the people in the program were saying “NOBODY teaches this stuff to grad students, and so many people need to hear this.” And it’s not just grad students, I know professors who could benefit from a course where they go and they teach.” She also wanted to add a practical component to her studies in Extension “I’d been taught it in school that this is what Extension would do, but I’d never actually SEEN it.”

In addition to gaining teaching experience, Sidney also hoped to gain an understanding of program management and development – a skill that will be important in a future Extension
career. “There’s sort of the feeling of being involved in helping move the Extension Scholars forward, so this is another thing that if I were interested in one day being [an Extension specialist] that would sort of give me insight and how to do that.” As a result of this perspective, she often applied what she was learning about classroom management to the management of adult teams, “I’ve been thinking if you have to manage a person it might be good if they felt like they owned some portion of the project. Because from what I’m understanding from this concept of letting the students be more interactive and involved - it helps them to want to learn more and it sort of builds something inside of them where they want to continue to improve.” In addition, Sidney was sensitive to the professional networking benefits to be gleaned from working with a cohort of students from multiple departments. She was eager for the opportunity to build positive relationships with fellow graduate students because “sometime in the future [I] may be working with them. And [my prior relationship] could affect my being hired for a position at their school. If they have a POSITIVE view of me it could benefit me.”

**As an extension of research.** Because Sidney’s research already lies on the socio-scientific side of agriculture, her Graduate Extension Scholars work was more seamlessly integrated into her academic agenda than for other participants. From early on in her participation, Sidney saw her Graduate Extension Scholars project as “just an additional layer” to her research. As the program progressed, this integration was expressed through the incorporation of her Graduate Extension Scholars work into grant-writing. By the conclusion of the program, Sidney was strongly considering adding a report of her program experience as a chapter of her thesis. Sidney wanted to leverage her GES participation as a practical supplement to her theoretical work.

One of the advantages Sidney saw to bringing her research to the classroom was the opportunity for two-way interaction adding to her understanding of her research. “Sometimes,
seeing something from a different point of view will enlighten you, so, I think that that’s something I would gain from talking to the students, Kendall, and Jordan. I’m going to able to see several different points of view on my project which is really valuable to me.” Therefore, even though Sidney’s research focuses on a topic of interest to adult agricultural producers, working with students and teachers contributes to her research by giving her a new perspective on the implications of her work and the how to best communicate research-based information.

An additional way in which participating in the Graduate Extension Scholars program contributed to Sidney’s research was in the development of her methodology. Having limited prior experience with social science research, Sidney took advantage of the opportunity to learn through participation in the research process. Sidney would ask questions of the researcher during “down times” before and after class or after interview sessions. Most of these questions revolved around method development, for example, the formation of survey and interview questions, and ways to address generalizability. Presumably Sidney utilized this information in addition to her own coursework and research on social science methods to inform the design of her own study.

**As a social responsibility.** Sidney expressed a sense of social responsibility toward outreach. However, she placed more emphasis on a personal sense of social responsibility than a professional one. Though the GES program was an excellent professional development opportunity for Sidney, she also saw it as something fun to do to give back to her community.

One of the primary motivators for Sidney to participate in the program was an interest in youth development stemming from her prior experience working with the FFA. A primary goal for conducting outreach activities was to encourage youth to pursue agriculture and higher education “Some of the high school students really get into the FFA program and I think it’s one
of the things that gets people interested enough that they want to go on to college.” The vein of youth development remained with Sidney throughout the duration of the program and was reinforced by positive experiences she had interacting with Kendall’s students. She concluded her final interview with an affirmation of her belief in the power of outreach as a tool for youth development, noting that “Inspiring students was a big main idea for me. I’d like to think that maybe there’s somebody who didn’t think about going into agriculture and [now] might want to. There was a girl in [Kendall’s class] who was hoping to go to Virginia Tech. So that really helps it to hit home because hopefully she will.”

In addition to motivating youth in general, Sidney saw outreach and Extension work as having a specific benefit to the educational system by providing more options of learning activities for students than would be possible in a traditional classroom. “Students have different styles of learning and because each program has a slightly different role, maybe that will help individual students to be able to understand based on their type of learning. So maybe it helps students to have a variety of people in their lives, teaching.” In addition, Sidney identifies outreach education as being inspiring and motivating to students, providing a more enjoyable atmosphere for learning than the traditional classroom “One of the things I was thinking about recently is that if somebody makes learning too difficult, it shuts off a student’s mind. And so if you make learning fun, the student will more motivated and they’ll be inspired to learn even more themselves than they would have if you had just taught them one little piece.” This idea that a variety of teaching styles can make learning accessible to a greater variety of learners was reinforced by Sidney’s experience in Kendall’s classroom, as Sidney noted “it really stuck with me when she said that some of the students in her class were discipline problems in other classes.
but not in hers. If you watched her style she was actually not the type who was controlling the students as much as some teachers do.”

Though the ideas of youth development and educational accessibility dominated Sidney’s discussion of the purpose of outreach, she did still hold traditional views of Extension as the dissemination of scientific information to the public. For example, she noted that an additional goal of the Graduate Extension Scholars program, “to help to get some research information presented to students in such a way that they will be able to assimilate the information,” which was similar to Hayden’s recognition of the role of K-12 agricultural education in changing agricultural practices. As Sidney progressed through the program, she came to realize that getting information out to the public was more than “just communicating information from the institution.” She noted the importance of connecting to one’s audience, realizing that there was “a bigger social side” to Extension. As Sidney put it, “educating the public ISN’T just about saying “Here’s the information.” It’s in the WAY you say it. It’s in the presentation.”

4.2.3. Sidney’s Learning Process. Sidney’s learning cycle was anchored in real-world experience developing and delivering her educational module, as well as observing, interacting with, and receiving feedback from peers and the professionals with whom she worked. Peers played a stronger role in Sidney’s learning process, whereas she relied on a smaller number of experts, mainly the program director and her community partners, for feedback. Sidney did not mention using specific models or templates, per se, but the lesson planning frameworks provided in seminar did assist her in guiding her module design. The relevant themes of Sidney’s learning process are described in more detail, below, along with supporting data.

Interaction. “A lot of [learning] was just in interacting with other people – things they said, things they mentioned happening to them, or in talking to the teacher. You learn things that
you didn’t expect to learn. I think it helps you to gain a new perspective.” Casual interaction with experts and peers served multiple learning roles for Sidney. Because she was unfamiliar with the setting, context, and level of resources typical to high schools, it was helpful to have a teacher to consult about ways to ensure her educational product would be useful and generalizable to other classrooms. In addition, the opportunity to interact with professional educators gave Sidney previously unforeseen insight into the nature of the teaching profession, including the way in which teachers leverage social connections in order to expand upon their limited resources and balance their busy schedules. “Talking to teachers – I got more information about HOW they’re trying to use social connections to help improve their own classrooms. And so that was very interesting. I picked up on some more ways of getting from point ‘A’ to point ‘B.’” Getting to know the program director also gave Sidney a role model for future Extension Specialist work, and hearing about her peers’ experiences helped Sidney anticipate challenges that might arise in Kendall’s classroom. Sidney’s interactions with the various members of the program community seemed to anchor her experience, and she referred to these interactions almost every time she discussed her learning process.

Observation. In addition to interacting with her educational role models, simply observing them also served an important learning purpose for Sidney. She describes the benefit of observing her partner teacher as a way to “prime” herself for what to expect when it was her time to teach “For one visit I got to watch her teach for a while, which was REALLY helpful. I could watch how the students were acting and how they responded to instruction. It helped me to have a frame of reference for when I was going into MY talk with the students.” This observational site visit was expected of all participants and was a component of the program which Sidney strongly advocated for maintaining in future iterations.
In addition, Sidney was observant of the professional conduct of the program director, who, as previously mentioned, served as a role model for Sidney. “Having a professor who’s going through the tenure process to LOOK to and say “OK, this might be a good approach” helps me in the future to plan for how I might approach it.” In particular, Sidney paid attention to the program director’s professional conduct. “There were times when people were worried “Ah! This is happening and what do we do?!” And she would just keep this totally composed look on her face and say, “Well, let’s try this…” or “This is how we’ll handle it…” “We’ll just kind of roll with the punches” was her mode of attack. And so I liked to see that.” Observing the program director gave Sidney cues for how to conduct herself professionally in the future.

**Experience.** Practical experience also served as a window for Sidney into the nature of both teaching and Extension work, from challenges as simple as email communication or as complex as addressing unanticipated questions in the classroom. Through trial-and-error Sidney learned that multiple reminders with specific goals elicited a stronger response from community partners. She also came to realize that even the most detailed lesson plans change upon delivery. “Seeing it in the classroom and seeing how the students are responding is totally different than having this beautiful plan on paper, ‘cause things don’t always work out the way you expected them. I was SHOCKED that somebody said “Can I use fish tank water on my plant?”

Participation in the GES program also exposed Sidney to a number of new professional experiences more generalizable to academia, such as presenting a research poster and delivering a conference presentation. For the most part, experiential learning was about the details of “how to,” for Sidney. For example, she describes the strategies she and her peers employed to engage the audience at the teaching conference where they presented their final results: “I realized that we needed to sort of brighten things up for them. I think that turning on the lights and showing
them more pictures really helped. And I really liked that the screen kept moving, because that created some motion besides the speaker. And then we were trying to get some of the people in the audience involved by asking some questions.” Reviewing the strategies that she and her peers used to engage the audience gave Sidney a concrete example of what works and doesn’t work for engaging audiences in the future.

**Instruction.** Though the program was primarily experiential, instruction still played a significant role, particularly in exposing Sidney to pedagogical frameworks around which to organize her lesson planning. “I’ve been using [what we learned in seminar] in developing the module. And I have to come up with more detailed information for [facilitating] the next class so I’m using the information I learned from other group members and I’m trying to build it in.” In particular, Sidney gravitated toward the 5E inquiry cycle she learned in seminar as an organizing principle for lesson planning, pointing it out as a strategy she might use again in the future.

**Feedback.** When describing her learning, Sidney often referred to iterative cycles of drafting and feedback from her peers, the program director, and her partner teacher. As opposed to fearing feedback, Sidney welcomed it as a part of the learning processes “It was REALLY nice to get all that feedback. It made me think of more detail. Because the more comments I got the more I got to thinking of different ways of presenting things and more ways of EXPLAINING things.” The intensive feedback process in which she was able to engage stood in contrast to her previous teaching experience, during which this component of learning was missing “When I was a TA, I did get to develop my own lesson plans, but I never KNEW if what I was doing was right. So it was nice to get input and edits from so many people.” Ultimately feedback served to help Sidney refine her work and feel more confident in the quality of her educational product. Feedback seemed to play the most significant role in the planning and curriculum drafting phases
of the project, though Sidney did receive some feedback from her partner teacher on her lesson delivery, as well.

**Reflection.** Another process Sidney referred to was that of reflection, or “thinking.” For Sidney, being away from seminar or her project site productive time to process new information. “I’ll leave after class and I’ll think about things further and sometimes something comes to me and I’ll add it to the module.” In addition, Sidney would reflect upon her experience during interviews, referring back to her thoughts and feelings in the moment of experience and developing reactions or new questions as a result. For example, she discussed the synthesis of her experience and theoretical learning from seminar in regard to classroom management: “It really stuck with me when [Kendall] said that some of the students in her class were discipline problems in other classes but not in hers. Clearly there’s something different going on with her. And if you watched her style she was actually not the type who was controlling the students as much as some teachers do. It was interesting to me when we got to the section in seminar when we talked about behavior management and we found out that when students felt like they had more control they learned better. So it makes me wonder if there’s some connection to the students acting out in other classes and [Kendall’s] teaching style that allows the students to be part of the lesson.” These types of synthesizing statements were fairly common in Sidney’s interviews, indicating that she was using that time for reflection, as well.

**Discourse.** Sidney appreciated the opportunity to engage in discourse with peers during the seminar. “I like the conversational structure of the class. When I was an undergrad, it was a lot of lecturing at people and everybody just sat there in their own cocoon. And we’re not doing that. This class is more interactive.” The purpose of discourse, for Sidney, was to expand her perspectives and consider alternative explanations for ideas. “When you hear from a different
perspective, sometimes you'll hear something that you didn't notice, yourself. And as soon as you hear it you realize “yes, that’s right.” So it sort of broadens your horizon.”

4.2.4. Helpful Program Components for Sidney. Sidney identified several overarching components of the program that facilitated the learning process, overall, in addition to specific activities like the seminar, site visits, and interviews. In particular, these included the social and technical support structure of the program. The role of these features in Sidney’s learning is described in more detail below.

A supportive community. One of the factors that kept Sidney motivated and learning in the program was the community of support she received from both her home department and the program cohort. One of her advisors was integral in her initial participation and “was advising that it would be a good opportunity for me.” She reported that during the program, he was consistently available to assist in thinking through curriculum or presentations for education conferences. Within the program, Sidney had strong faith in the program director, whom she described as “Fantastic. I know that if there’s going to be a bump the road she’s going to find a way around it.” This faith in the program director’s support was important for Sidney, because it took a few weeks longer to recruit her community partners as compared to the other Graduate Extension Scholars. It was likely helpful that Sidney already knew the program director from taking a class with her and therefore was confident in her diligence. Furthermore, Sidney felt welcomed and supported by her peers “I look at them as colleagues and friends. I feel like I can be open and tell them about any issues and bounce ideas off of them.” Being welcomed into the community of the program made Sidney feel “really excited because I feel like I sort of have a place and helping with the program and helping it to get better.” A primary advantage of the cohort structure of the program for Sidney was the opportunity to learn from others’ experiences
“It really helps because some of them are at different stages in their project so I get to hear about what has worked for them and in some cases I find that useful.” Having a positive experience of group collaboration within the context of the program community also improved Sidney’s outlook on future team-based work, noting that “In lot of the GROUP situations I’ve been in before I felt like I was doing the work and everybody else in the group was sort of not engaged. THIS was the TOTAL opposite. Everybody was into it, and whenever I would come in and [ask for feedback] they would give me THEIR ideas and they were well thought-out ideas. So one of the things that I got out of it was the POWER of a GOOD group to be able to achieve some goal.”

**Defined structures for accountability & technical support.** For Sidney, the accountability structure of the seminar was integral to the learning process by providing her with direction “[During seminar, the program coordinator will] talk about where she was hoping to be in the program [by] now and helps you to think about what the next step should be. Because sometimes if I didn’t have that kind of guidance I think I would be saying “what do I do now?”” The cohort structure additionally provided accountability and motivation for Sidney to keep up with the program timeline “Sometimes in class they’ll be a point by which we wanted to have had something done and [my community partners and I] are not quite there yet. So it helps in class to hear about it [from the other students]. And then to get the scheduling all done with the teacher and the extension agent so that I’m on the same page [as my fellow cohort members].”

From the standpoint of technical support, Sidney appreciated the program coordinator’s availability for feedback, as well as the level of detail she provided. “Hannah would wrap her brain around exactly what I was talking about. She would try to give the best advice she could, which often was REALLY good. So I appreciated that. And she would email back pretty fast.” As
mentioned previously, this feedback enhanced Sidney’s knowledge of curriculum development. Additional sources of technical support for Sidney included her advisor, who occasionally reviewed her curriculum and presentation materials for content accuracy, and Kendall, who assisted Sidney in modifying her curriculum materials for the resources and interests of her class.

4.3. Case Study - Laurie

4.3.1. Participant Biography. Laurie is a first year Ph.D. student in the department of Crop and Soil Environmental Sciences. His research revolves around the assessment of crop residue-based bioenergy production systems. Specifically, Laurie seeks to determine sustainable corn stover removal rates which optimize tradeoffs between biofuel production potential and ecosystem services in coastal Virginia soils. This biofuel work is of particular interest to Laurie due to its implications for reducing fossil fuel dependence while also economically benefiting farmers by diversifying their production systems. His interest in agriculture is motivated by altruism in addition to scientific curiosity, “Since I was a child there was two VERY clear things in my mind related to my professional career. I wanted to be a researcher and I wanted to do research in order to improve the quality of life for other people. I wanted to help the world.” He attributes some of this motivation to having grown up in Argentina during an economic crisis at the end of the ‘80s. As a first-generation college student, pursuing a Master’s and then Doctoral degree in the United States is a point of pride for Laurie. He sees having a successful scientific career as a way to “give back” through innovations that will help people in his home country and around the world.

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16 Stover consists of the stalk, leaf, husk, and cob remaining in the field following the harvest of grain. Using stover for biofuel feedstock allows growers to harvest the grain for separate markets, diversifying their business portfolio. 17 Returning some crop residue to the field helps maintain soil quality and prevent erosion.
Laurie’s interest in teaching and outreach stems from his desire to share his passion for science and to stimulate students’ curiosity. “To be a teacher is a wonderful opportunity to show people the beauty of research - how exciting and helpful research can be. It means to uncover the excitement of learning new things.” For Laurie, the main benefit of teaching is to inspire others to engage in scientific pursuits and to contribute to the advancement of human knowledge. “Teaching for me is delivering this message – there’s a lot to know, we don’t know much about a lot of things, let’s go out together and uncover the beauty.” Laurie had some prior teaching experience as a graduate assistant during his Master’s degree, which he described as “a really, really constructive experience.” This experience affirmed Laurie’s interest in becoming a professor “to do research but also to teach” and led him to pursue his doctoral degree. One of Laurie’s key frustrations with his previous experiences with graduate education was a lack of opportunities to develop professionally as a teacher. “Many of us grad students want to be professors. And they don’t teach us how. I think that we needed something like that and it’s really good that we have this [the Graduate Extension Scholars program]. This is something that it wasn’t present before in our curricula.”

Laurie was paired with Harper, a seasoned agriculture teacher at Overton High School and with Emmerson, the veteran 4-H agent for Overton County. He was the only scholar who successfully engaged with both partners’ programs, delivering five lessons to Harper’s 11th and 12th grade agricultural production students, and conducting two visits to Overton Elementary as part of a school-based 4-H enrichment program. Laurie’s lessons focused on career opportunities in agriculture and the process of agricultural research in general, with loose connections to his biofuel and biochar research. For the younger group, Laurie also touched on plant growth and development with a hands-on corn planting activity. In addition to conducting programming
during the school year, Laurie also engaged some of Harper’s high school students along with Emmerson’s home-school 4-H club in a simple corn biofuel yield experiment over the summer months. The students sampled the soil in the school yard of Overton High and planted a test plot corn with the intent of establishing baseline yields to compare against those influenced by future application of biochar and/or different stover removal rates.

**Key Learning Outcomes.** One of Laurie’s concerns coming into the program was how he might learn to adapt his communication techniques for a new audience, noting that “I haven't been working with young guys so for me it’s a new experience. How will I do it?” Though he noted that it was challenging at first, Laurie ultimately learned “how to depart from the scientific rigor” necessary for “university science,” adopting a more casual and simplified instructional approach necessary for “school science.” Laurie noted that writing for the poster and for his curriculum module further aided him in learning “to put my science in a way that can be understandable.” Reflecting on his final outreach engagement upon exiting the program, Laurie noted the progress he had made, “I realized how much I learned because it was so different - the way that I talked with the kids. I just brought down the level of my science in order for them to understand. So I think I increased my abilities to speak with a non-scientific audience.”

This shift in instructional approach was also observed by the researcher over the course of subsequent site visits. Though at first it was challenging for Laurie to break out of the habit of using a formal academic language, over time he became more comfortable with simplifying concepts, slowing the pace of discussion, and relaxing his affect to be more accessible to younger and more inexperienced audiences. Furthermore, Laurie became more comfortable with uncertainty in teaching, noting that “I learned to leave an open space for random stuff that can just appear, that can just come up without any prior schedule.” He also came to better
understand the relational nature of teaching, noting that “I felt a little uncomfortable at first, working with the high school students. But then I realized that it’s just a question of time. They need to trust you.”

An additional, unanticipated learning outcome for Laurie revolved around the process of social science research and communication. As one of the two participants who took advantage of an opportunity extended by the program director to attend a national agricultural teaching conference, he was confronted for the first time with the question “How do you show RESULTS in the social sciences?” In the process of working on his poster for the conference, Laurie came to realize that social science is “a quite different approach. You’re no longer measuring a number. Rather, you are observing people and measuring perceptions, which means that you have to look at the way that people BEHAVE.” Laurie felt having some functional knowledge of social science research would aid him in his future work “One of the concerns that we have is how other people are looking at biofuels. And [before] I didn’t have a way to measure that. Now I think that I have more skills, so I can also look at that side, which is extremely important for the future adoption of biofuels.”

**Key Perception Changes.** Over the course of the program, Laurie experienced several changes to his perception of the teaching profession and process. At the beginning of the program, Laurie admitted that “I sort of underestimated the job [teachers] have.” However, over time, he developed more respect for their craft, noting that, “I changed my mind about the difficulty of teaching. NOW I know that it’s not only [about] factual knowledge. It’s also the knowledge that you need to have about people’s behavior. I have much more consideration [for teachers] now.” Laurie also became more open-minded toward collaboration with K-12 educators, noting that “I have been tearing down these walls that I envisioned between these two
worlds [of university and K-12 educators]. If we have the desire, the time, the engagement, and the resources, we can connect in wonderful ways.”

In addition to changing his perspective on the teaching profession, Laurie also experienced a shift in teaching philosophy. During early seminar sessions, Laurie was a strong advocate for direct-instruction. However, as he continued to be immersed in a community of constructivist educators who espoused the “learn by doing” model of 4-H and FFA, Laurie began to shift his perspective, noting that he “minimized the idea of lecturing over time.” Laurie summed up his shifted toward student-centered instruction as follows, “As I go through this process – and probably that was implicit at the very beginning but I didn’t catch it – I’m realizing it’s not only about me, it’s also about the students, it’s about hands-on experience.”

When Laurie first began the program, he reported primarily individual goals. “I was just mostly thinking [about] my professional development.” However, as he progressed through the program and developed relationships, Laurie shifted his perspective. He notes, “my expectations are bigger [now] because they also encompass the students and teachers. I think that we can build a really nice long-term relationship.” For the remainder of his experience in the program, Laurie was a strong advocate for longer-term community involvement in order to make a lasting impact on the youth. Indeed, Laurie was so committed to this ideal that he chose to continue his outreach to Overton County many months after the program had concluded. Laurie shifted his idea of outreach from “reaching scientific audiences” to “outreach to people in a broader sense,” developing a strong sense of commitment to and advocacy for K-12 outreach, promoting the Graduate Extension Scholars program at every available opportunity.

4.3.2. Role of Outreach in Laurie’s Professional Identity. Laurie saw outreach as part of his professional identity before participating in the Graduate Extension Scholars program, but
his experience served to enhance and refine his views on the role of outreach and teaching in his personal and professional life. Participation in the GES program was mainly a way to increase his professional competence around outreach as well as fulfill his commitment to the land-grant mission. Key themes relating to Laurie’s professional identity development are described in more detail below.

As professional development. Laurie was initially attracted to the Graduate Extension Scholars program as a way to supplement his assistantship funding, but also as a way to grow professionally. “I want to be a professor, I wanted to have greater exposure to Extension work - and I got the [GES recruitment] email that happened to be spread to the entire department. So I think that it was a perfect moment for me because I was looking for something like this.” From the start of the program, Laurie acknowledged the fact that different audiences require different communication techniques, and that his experience teaching undergraduates was a good start, but would not be sufficient to fully prepare him for the diverse groups he might interact with as a professor of agriculture. Participating in the program was an opportunity “to hone my teaching skills and enhance my communication skills with farmers, with agents, and with youth, because of course it's not the same. I need to learn all these different approaches in order to understand the different cultures and people that I most likely will work with.”

Furthermore, as a Ph.D. candidate targeting a career in the competitive world of academia, Laurie saw participation in the Graduate Extension Scholars program as a way to expand his professional portfolio, giving him an edge on other candidates who focused more narrowly on their research. Laurie used the program as a mechanism to network more broadly in the field of agriculture and demonstrate his well-roundedness through presentation at education-related venues in addition to the traditional conferences attended by members of his field.
“Before starting [the Graduate Extension Scholars program], the publication scope for my research was usually, you know, the Agronomy Journal or the Crop Science Journal, all this kind of stuff. NOW I have something else in my portfolio [a NACTA poster]. I’m so happy I have started exploring this new world of the social sciences. It’s something that is not in our curriculum. I feel like I learned a lot and I have these extra skills that the other students in my department most likely don’t have, so it puts me at an advantage.”

At the conclusion of the program, Laurie felt that he had achieved many of his professional development goals around teaching and had also advanced his scientific abilities, acquiring additional social science communication and research skills that he had not anticipated he would learn. However, professional development also took an increasingly smaller role in Laurie’s participation as he progressed through the program. Toward the conclusion of the program, Laurie prioritized the social benefits of outreach over the benefits to scientists. Key themes relating to Laurie’s conception of social responsibility toward outreach are described later on in this section.

**As career exploration and affirmation.** “Teaching was always an interest of mine. Before coming here I was teaching undergraduates for two years at the University of Kentucky. But surprisingly for me, I felt much more motivated teaching [younger] kids. So, for me, teaching now seems more fun than it was before. I feel I’m contributing to society to a much greater extent. I’m not just thinking about people who are related to agronomy. I have broadened my scope and I think the impact that I can make is even bigger. So teaching for me is [now] more compelling because I realized the power I have to influence and impact young people.”

As evidenced by the quote above, while Laurie had an interest in teaching prior to participating in the program, his exposure to teaching in the K-12 setting both reinforced his
interest in teaching and expanded his target audience. Initially, teaching was an essential part of Laurie’s job that contributed to the development of the agronomic workforce. After participating in the program, teaching had reached an elevated status in Laurie’s identity – a way for him to give back to society while also genuinely enjoying himself. This discovery reinforced his commitment to participating in educational outreach activities in his future career.

As a social responsibility. Like his fellow Graduate Extension Scholars, preparation for professional responsibilities was not the sole motivator for Laurie’s participation in the GES program. Laurie identified strongly the university’s land-grant mission of community service, noting “that was one of the things that moved my decision to come [to Virginia Tech].” Coming into the program, Laurie was an avid proponent of the land-grant mission of public service. “When I came to Virginia Tech, I was amazed with the idea of community. I haven’t seen that in other states. And I think that we can even strengthen that a little bit more by bringing these [teachers and 4-H agents] closer to the university. As a VT student I think that’s AWESOME.” Participating in the Graduate Extension Scholars was a way to live out the university’s mission of “Ut Prosim” and give back to the community. It was also a way to strengthen relationships between the university and the wider community in fulfillment of the land-grant mission. Laurie’s commitment to community partnership continued to strengthen as he progressed through the program.

One of Laurie’s initial goals for being involved in Extension and outreach activities was to share his research efforts with the public in order to generate interest and support. As an agricultural researcher, he faces resistance from the status quo. Laurie therefore recognizes the importance of effective communication and outreach skills in order to “spread this kind of thinking and to make more available to farmers this kind of holistic approach.” For Laurie,
outreach is an essential vehicle for the diffusion of new innovations and the creation of new markets for the practices he and his colleagues were in the process of developing.

While outreach to farmers was always a professional expectation for Laurie, as he became more familiar with it through the program, he began to see youth education as an additional vehicle for agricultural training. It did not take long for Laurie to fold youth outreach into his professional goals, announcing after only three weeks in the program that “I would like do this in the future, either here or in Argentina. I would like to be doing research, be connected with youth, and also be connected with farmers.”

From the start of the program, Laurie saw his involvement in outreach activities not only as a mode of farmer development, but also as a vehicle for youth development. Specifically, Laurie hoped to encourage young people to join the scientific agricultural workforce, “The greatest thing I want to do by teaching is to inspire people to study agriculture and hopefully enroll in [college].” Initially he hoped to do this implicitly, by sharing his research and inspiring interest in science. As he progressed through the program, and with the influence of his partners, Laurie shifted his curriculum ideas for the high school group to more explicitly address his youth development goals. “I want to encourage these guys BEYOND the idea of science. I want for them to love science but also to think about the future. Hopefully many of these kids in the 12th grade will think seriously about going to college if they don’t already. For the ones that already [plan to go to college], it’s hopefully giving them another idea that after their bachelor it will be really wise to continue with graduate school.” Therefore, for Laurie, the goal of outreach was not only to inspire youth to enter the field of agriculture, but to encourage them to develop themselves and to pursue higher education in general to advance their personal and professional development regardless of their field of study. This shifting goal was explicitly addressed in his
curriculum module through activities that showcased career opportunities and benefits of a college education.

From early on in the program, Laurie echoed the sentiments of the National Academy of Sciences (2009) and the American Association for Agricultural Education (2011) in recognizing the value of outreach to generate interest among youth in pursuing a career in agriculture. Though he supported these types of efforts generally and for all age groups at the beginning of the program, his experience working with different age groups shifted his perspective somewhat. By the end of the program, Laurie had further refined his idea of the role of outreach in recruitment by defining a specific target audience – upper-elementary and middle school aged youth. “I think that we can impact young kids to a greater extent than the 11th and 12th grade kids that pretty much have MADE their decision about what career they’re going to follow. So, if we want to make a HUGE impact I think that we need to target YOUNGER students.” Though Laurie recognized the value of sharing agricultural knowledge, in general, an additional priority of his was recruiting future agricultural professionals. This priority was de-emphasized somewhat over the course of the program as Laurie began to recognize the other benefits youth could glean from having a scientist as a mentor.

4.3.3. Laurie’s Learning Process. Laurie’s learning cycle differed somewhat from Hayden’s and Sidney’s in that he did not emphasize instruction or models so much as experience and feedback. Laurie seemed to thrive on experimentation followed by just-in-time instruction. In addition, Laurie more frequently referred to the relationship between theory and practice in his learning. Key themes relating to Laurie’s learning process are presented in more detail below.

Experience. Motivated by his interest in becoming a teaching faculty member, Laurie had previously investigated opportunities to develop his teaching skills through a nine-credit
certificate program offered by the graduate school. He was also enrolled in a one-credit seminar required of all teaching assistants which consisted of a three-day training session followed by three follow-up seminar sessions throughout the semester. Laurie’s primary criticisms of both of these programs was a lack of practical application “We didn’t have this hands on [approach]. It was too much technical stuff, too much theory.” He appreciated the experiential approach of the Graduate Extension Scholars program, describing it as “a wonderful opportunity for us to start learning the basic principles of being a teacher with a hands on, minds on approach.” The experiential nature of Laurie’s learning process is reflected in his frequent references to having learned “by experience,” or “from my own experience,” when discussing different learning outcomes he felt he had achieved from the program. Like his peers, and in keeping with the program’s intent, Laurie’s learning was cemented in the experience of developing and delivering his educational module. However, it should be noted that unlike his peers, Laurie’s module took on a more “free form” or experimental development process. Rather than moving from instruction and observation to planning and module delivery in a linear fashion, Laurie worked in a more iterative way. He developed and delivered an activity for his very first site visit, and then solicited feedback and used this experience to anchor future learning in the seminar, modifying his approach accordingly for subsequent activities.

Feedback. As a K-12 education neophyte coming into the experience from a completely different cultural context, Laurie was unsure at first of the expectations for communicating in the educational setting. He therefore relied heavily on guidance and feedback to compliment his practice. He would frequently send written material to the researcher or program coordinator in advance for proof-reading and editing, and would formally request feedback on his performance from both the researcher and his community partners at the conclusion of each site visit. He
attributes practice combined with feedback to the majority of his learning. “We talked a little bit about reducing complex ideas [in seminar]. But mainly through experience and though the feedback that you, Emmerson, and Harper provided, I learned and will apply the process of reducing complex ideas to something that [students] can understand.” Laurie acknowledges the role of feedback in achieving previously-mentioned learning outcomes, noting that “At the beginning you worked with me and pointed out many things [I could improve]. Then, in my last session when I was asking my partners for feedback, they told me that I was doing great.”

Though Laurie took advantage of every possible opportunity for feedback he could, he still desired more from his partners as well as peers and the program coordinator. An ideal program environment, for Laurie, would have incorporated direct observation of his instruction and feedback from all parties involved in the program. As Laurie notes, “The moment that we have to shine is when we are with the kids. And that’s the moment when we need more feedback, but most of the time I was alone. I really liked the input from Emmerson and Harper, but they are not prepared the way the Hannah is in the social sciences.” This desire speaks to his appreciation, not only for feedback, but for a variety of diverse perspectives on his work.

**Application of theory.** As mentioned previously, the Graduate Extension Scholars program promoted a constructivist experiential pedagogy and delved to some extent into the theoretical foundations of the constructivist perspective. Laurie expressed a particular appreciation for the incorporation of a theoretical framework to compliment the experiential nature of the program. The seminar setting served as an example of what constructivist learning might look like, giving him a model from which to work when he progressed to curriculum delivery at his partner site. “There is a connection between what we are supposed to do and what we are doing in seminar. I am enjoying this because it’s a really novel approach. We all see the
world differently. We are constructing learning. I think that we have a really clear connection between what is going on in the seminar and what is going to happen with the kids. If we talk about flow, flexibility, and open ideas, but we don’t have them here, it wouldn’t work.”

Exposure to educational theory in the seminar also helped Laurie to situate and get more out of the advice he received from professional educators Harper and Emmerson. “In seminar we are building up the scaffold. [Harper and Emmerson] give me the big ideas. In seminar I get the rest.” For Laurie, his educational partners represented practical and experiential knowledge, whereas the program director and researcher represented theoretical knowledge, which combined, contributed to Laurie’s understanding of constructivist educational practice. As mentioned previously, the only thing that Laurie felt would have strengthened his learning would have been the opportunity to incorporate more theoretical discussion into the feedback he received on his teaching, noting that “Even though I realize that the input from the teacher and Extension agent is worthwhile, it’s limited, also. Because they can only speak from experience, they don’t have the theory backing up everything they say.”

Observation. Observation of individuals he perceived to be outreach ‘experts’ was an additional method via which Laurie strove to improve his own skills. When the program director extended the opportunity to observe her delivering an outreach activity to an elementary school group on campus, Laurie took advantage. Observation also served as “just-in-time” instruction for Laurie, who, upon receiving feedback on his performance with an elementary school group during his first site visit, asked the researcher to demonstrate facilitation of the “engage” portion of the lesson for the next group. In addition, Laurie would have liked to observe his fellow Graduate Scholars in order to learn from them, acknowledging the value of peer observation in his mid-point interview providing feedback on the program: “Each student should have the
responsibility to visit the other sites and just be present for at least one of the lectures of their fellow grad students. We have to see the horses in the field - as we say in Argentina. Just go over there and see how your fellow grad student is leading the class. This is a learning process for all of us. They are high achieving students so it is good for me to know what they are doing.” Laurie summarized the value of observation as an opportunity to learn from others’ expertise “I always like to take somebody else’s experience. I am not the kind of guy that says we have to invent the wheel again. We have to see people that build up successful stories. And we have to walk behind them. And I think that we can take really good inputs from those people.”

Reflection. For Laurie, limited prior experience with the science of education resulted in initial feelings of being overwhelmed. “The challenge is just that – it’s a lot of information which is not related with anything I have seen before. I’m an agronomist. I know about plants, I know about soils [and investigate and try to learn what I do not know]. I never had all of these ideas. It was complicated for me to decode all these terms.” Individual reflection was a process of sorting through all of this new information and selecting the pieces that made sense for his project and partner site. “I overcame that challenge by thinking “You know what, Laurie? They are just giving me different tools. It doesn’t mean that I need to use all those tools in my presentation.” So I’m putting together all this learning, compressing it, taking some parts and putting my passion into it. Because I know that I have that. It was a lot of information and that was the big challenge - more like a classroom challenge or a lab challenge [which I worked through] myself at home writing, thinking.”

Discourse. An additional tool that Laurie used to work through his ideas about education was discourse – facilitated by questions posed in seminar. “I think that it was a really good space to agree with and encourage each other, but also to disagree. We were able to say what we wanted
within respectful limits. Sometimes I was in disagreement with [the others] and I think I expressed that in a timely and politely fashion. And they did the same with me. We were able to build up an open space for debate.” Discourse enabled Laurie to re-evaluate some of his previous notions and encouraged him to question and expand his thinking. “It made me wonder if my approaches [to teaching] are right or not. If I am being debated by one or two people, I start opening my eyes and thinking of something else.” Laurie expressed appreciation for the opportunity to share and be exposed to diversity of perspectives and viewpoints on the issue of effective teaching practice within the framework of the seminar.

Interaction. For Laurie, building professional relationships with K-12 educators resulted in a significant mental shift for Laurie about the challenge and value of teaching. Though he respected the role teachers played in society, before working intimately with teachers he underestimated the skill required for them to do their work. Working with Harper and Emmerson gave Laurie a new perspective on teaching as a profession which increased his empathy for teachers and elevated the profession in his mind. Interacting with Emmerson and Harper also tore down mental barriers for Laurie, making it easier for him to envision working with teachers in the future. “Mainly by experience, but also from the theory that we have learned, I have been tearing down these walls that I envisioned between these two worlds [higher education & K-12 education]. There’s not a wall. We can just connect. If we have the desire, if we have the time, if we have the engagement, and we have the resources, we can connect with each other. But before there was this wall in my mind that sort of avoided this connection. [Before] I never thought about working with schools, it wasn’t even on my mind. So, my consideration and my respect for the work that they are doing has increased for GOOD.”
4.3.4. Helpful Program Components for Laurie. Social and technical support were important overarching program features that eased Laurie’s learning experience. Compared to peers, however, Laurie actually desired *more* social support from the program, especially in the forms of peer-to-peer interaction and expert feedback. He also relied more heavily on the program staff for technical support than other students, but did not involve his advisor. Finally, Laurie more explicitly pointed out the role of the program’s theoretical framework in guiding his learning. These helpful program components are described in more detail below.

*A supportive community.* Though Laurie had a very positive attitude about the program and was motivated on a personal level, he also relied heavily on the social community of the Graduate Extension Scholars cohort, community partners, and leadership. Being a part of a welcoming, engaged group with accessible and flexible leadership eased worries and tensions for Laurie. The group setting also helped Laurie feel comradery in overcoming the challenges of the program “*We are learning all together. So I know that some things will come up, but we have a really good group and I think that we are overcoming all those difficulties.*” Laurie’s community partners also provided emotional support by putting his experience into perspective. “*Just [having] people to say “you know, you’re going to face some challenges, but it’s OK. It’s something that is going to happen [is helpful].”*

Indeed, social interaction was such an important component of the experience for Laurie that he repeatedly expressed a desire to have *more* peer interaction than the hour-long weekly seminar to expand learning beyond the technical support needed to complete his outreach. “*I mean, in my project I need probably 80% Ayla’s, Hannah’s, and my teachers’ help, and probably 20% of the group. So with that hour a week I have that. But I think that in the future, it may be nice to have a stronger relationship among the students.*” The primary function a
stronger relationship with his cohort would have served for Laurie would have been emotional support during site visits. “It was really encouraging for me when you visited with me and I would love to go again with you, but I understand that you cannot. OK, somebody else could. I have to share [the experience] with somebody else. I feel I am missing something [if] I’m going to go over there in fourteen days ALONE. We are missing the ‘learning all together from our own very experiences’ component of this wonderful program”

Laurie appreciated the social support that the Graduate Extension Scholars community provided, and the access to education experts created through Hannah’s incorporation of guest speakers, but Laurie wished to expand this community even further. He viewed the geographical distance of Graduate Extension Scholars’ project sites from one another as a barrier that prevented full participation as a community in one another’s projects. Further, he expressed a desire to have more and deeper participation in the seminar by additional education experts and even the Graduate Extension Scholars’ research advisors. In essence, Laurie recognized the value of the learning community he had during seminar, but he also saw this community as restricted to the cognitive apprenticeship and wished to expand that to all aspects of the program and other areas of his life as a student.

Available technical support. As an international student unfamiliar with the culture of public education in the United States and still acquiring a grasp of the English language, Laurie relied heavily on the program coordinator and researcher for technical assistance, namely proofreading and clarification on the factors he would need to consider when planning his lessons, including learning standards alignment, grade-level appropriateness of activity ideas, and time constraints of the four-block schedule at the high school level vs. seven period format at the elementary level. He also relied heavily on performance feedback from his community partners
and the researcher during site visits. This technical support assisted Laurie in honing the skills of communicating in the K-12 educational setting, including writing lesson plans and simplifying scientific information.

**Guidance from a theoretical framework.** At first the discussion of educational theory in seminar was overwhelming to Laurie, who was unfamiliar with the science of pedagogy. However, as time went on, Laurie came to appreciate the exposure to different educational approaches. Though Laurie may have applied the pedagogical techniques presented in seminar to a limited extent, the program’s theoretical frame did provide Laurie with a starting point from which to expand upon his knowledge and skill in teaching and learning. “I don’t remember all the theory behind all the 7 E’s, but I remember the concept and I know where I can find that information. So I will use that in the future too. I’m not using it that much right now in my curriculum, to be sincere, but I think that was one of the most important aspects of this theoretical training.”

4.4. Case Study - Cameron

4.4.1. Participant Biography. Cameron is a first year Ph.D student in Plant Science studying biotechnological applications for disease management. Cameron switched into plant science from a chemistry lab which was studying drug design and delivery, citing a desire to move from an industry-focused department to one that was more welcoming of graduate students interested in teaching and basic research. Cameron appreciates the direct social impact of research “diseases of plants are very devastating and understanding is the key to controlling them” and credits the departmental switch with the opportunity to participate in the Graduate Extension Scholars program vis-à-vis his new advisor’s recommendation.
Cameron’s interest in teaching and outreach is driven by a desire to inspire others to share in his wonder for the natural world. “My real passion is science advocacy. I love the beauty of science and I really want to impress that upon other people.” He sees communication and outreach as essential components to a future career as in academia, industry, policy, or science advocacy. He personally values education as a mechanism for enriching the lives of others, noting that “every person should have an opportunity to learn and to get excited about something… education allows [people] to pursue what makes them fulfilled and happy.”

Though Cameron had limited prior experience with agricultural education before entering the Graduate Extension Scholars program, he had previously served as a teaching assistant for a variety of undergraduate-level chemistry and biology courses. From these experiences, he came to value instructional autonomy and the opportunity to build relationships with students. As an educator, he emphasizes sharing science “not as a body of knowledge but as a process.” Coming into the program, Cameron was comfortable with direct instruction or “traditional lecture style” teaching. His favorite aspects of instruction include formulating stimulating questions and explaining processes. Entering the program, he expressed excitement and interest in learning more about K-12 agricultural education systems.

Cameron was paired with Erwin County High School (ECHS), which had a strong and well-funded agricultural education program that enjoyed robust community support. ECHS had worked with the university and local agencies to secure a grant to build a state-of-the-art STEM laboratory in their agricultural department. The lab was equipped with standard molecular biology equipment, including a PCR machine, autoclave, micro-centrifuge, and gel electrophoresis kits. ECHS agriculture teachers had begun to teach classes in agricultural biotechnology – one of only three schools in the state to do so. The development of the STEM
lab and associated curriculum was very much in the experimental stages, and the focus of Cameron’s outreach work quickly expanded from sharing his research and knowledge of molecular biology with students to helping the ECHS staff become familiar with their new tools.

Cameron worked primarily with Jesse, a seasoned agriculture teacher, and Morgan, a biology teacher who had taken on the additional responsibility of overseeing the STEM lab. His outreach project ultimately consisted of a training session for teachers in the agricultural department interested in learning basic procedures for DNA extraction, amplification, sequencing (vis-à-vis a third-party laboratory), and identification using the NCBI BLAST system. In addition, Cameron delivered an interactive unit on genetic identification of pathogens to one of Jesse’s classes. The county 4-H agent was also involved, initially, but resigned from her post shortly after the program began, which limited Cameron’s outreach to the high school level.

**Key Learning Outcomes.** Coming into the program, Cameron was completely unfamiliar with the form and function of K-12 agricultural education “I didn't really know anything about FFA, Virginia Extension, or 4-H.” However, by the conclusion of the program, he was able to discuss their respective roles and activities in detail. Furthermore, though Cameron had been educated in the U.S. public school system, the program introduced him to the modern learning technologies and resources that now characterize the classroom setting “[Jesse] was using a computer system that allowed him to put in his own material and provided students with the readings and all of the things that [previously] had to be done by hand.”

However, Cameron also came face-to-face with the limitations in time, resources, and expertise that persist in the educational system, noting that “it is kind of disheartening that this kind of collaborative, exploratory teaching takes more time.” In his exit interview, Cameron also reflected on the process of compromising expectations, “When the Extension Scholars were
initially PRESENTED it was “take some of your research, bring it to the classroom.” I found something that WASN’T as discovery-oriented as I’d initially hoped, but was still able to incorporate some of that. My major disappointment was that AFTER you choose what you’re going to analyze, it’s really just following instructions. But I think I tried to find a compromise where it still connects to my research and I’m still able to convey some things that our research is trying to accomplish.” The various challenges Cameron experienced gave him a more realistic understanding of the challenges teachers face in balancing limitations of time, resources, and content when attempting to implement inquiry-based and hands-on activities.

In terms of skill acquisition, Cameron reported having made progress “toward my goal of being a science communicator and being able to articulate my work.” Particularly, he expressed that participation in the program had strengthened his ability to simplify and contextualize scientific information for lay audiences “One of the biggest things I’ve learned and am definitely STILL learning is how to organize myself around this information. Reducing things. Making analogies. Relating it to something that they do or see in their everyday life.” In addition, Cameron noted that his understanding of how to effectively guide inquiry-based learning had improved. Reflecting on his prior experience, Cameron pointed out that “I kind of pigeon holed students or LED them to ONE answer. And I think it RESTRICTED their ability to explore and figure things out on their own. Thinking long and hard about ways to try to get students to think creatively on their own, both in the seminar and while trying to develop my module, was really beneficial to my understanding how to educate in that [inquiry-based] way.” Finally, Cameron reflected that he came away from the project with a better understanding of how to work collaboratively with community partners on project planning “I think I HAVE learned how to engage the stakeholders. I really want everyone to get what they want out of it.”
**Key Perception Changes.** As a result of participating in the program, Cameron reported a positive attitude shift toward 4-H and FFA, noting that “the more I’ve interacted with these programs, the more respect I have for them.” In addition, he developed an appreciation for the role of the Department of Agricultural, Leadership, and Community Education in teacher professional development and support of Extension education programs, noting that his experience “really reinforced the BENEFIT of this department.” He also developed a greater sense of the resources available to him as a scientist at the university. Overall, Cameron came away from the program with “a new appreciation of education and redefined goals not just for this project but in my life,” which represented a more professionalized view of educators and a stronger commitment to supporting educational outreach efforts.

Prior to participating in the program, Cameron ascribed to the commonly held belief that teaching as a “lonely profession.” However, he came away with hope that “there CAN be a lot more integrated collaboration between teachers.” In addition, Cameron’s sense of the possibility for discovery and partnership with K-12 educators was expanded, noting that his experience had “torn down the distinction” between scientific research and education and posing the question “Why CAN’T high school teachers and students work together to discover something NEW?” Over the course of the program, Cameron developed more questions about educational practice and adopted a strong commitment to inquiry-based learning and student autonomy, adopting an attitude that “A teacher isn’t there to get the student to do something it’s to show them opportunity,” and that student motivation would come with the opportunity for relevant inquiry.

**4.4.2. Role of Outreach in Cameron’s Professional Identity.** One of the goals of the project that was particularly interesting to Cameron was the aim of connecting the wider community with current research being conducted in the College of Agricultural and Life
Sciences (Scherer & Jamison, 2014). Participating in the Graduate Extension Scholars program therefore gave Cameron an outlet for his interest in science advocacy and communication. Having expressed an interest in pursuing science education and advocacy regardless of whether he is employed in academia, industry, or policy, Cameron sees participation in the Graduate Extension Scholars program as a way to prepare for that goal: “I think that is a new challenge but a real opportunity because my goal is to be able to pass that [love of science] on to anybody.” The relationship of outreach in general as well as the GES program, specifically, to Cameron’s identity as a science advocate are discussed below.

**As career exploration and affirmation.** Perhaps one of the most significant ways in which Cameron incorporates his Graduate Extension Scholars experience into his professional identity is as an affirmation of his interest in STEM outreach and education. Though he describes himself as having a life-long inclination toward teaching and an interest in educational issues, he previously felt as though his field did not honor these inclinations and interests. Cameron’s new advisor in PPWS, however, shared Cameron’s value in outreach and recommended him for the Graduate Extension Scholars program when he became aware of Cameron’s interests. In a supportive environment surrounded by like-minded peers and with his advisor’s blessing, Cameron was able to explore his interest in education in a professional capacity. As a result, Cameron notes, his interest in outreach and education as a possible career was strengthened and affirmed: “having an opportunity like THIS has helped me realize that it’s more what I want to do.”

In addition, exposure to a variety of professionals and opportunities within the realm of outreach and extension education helped Cameron further refine his career goals around education and what that role might look like. “This experience HAS really made me entertain the
idea that academia might be a good choice, maybe at a school that’s more education focused because I DO enjoy that classroom setting so much. And even as I complain about [my research] I would really love to exist at that interface BETWEEN research and education rather than solely in one or the other. And I think this program - where students are taught to think for themselves and use the scientific method to understand the world around them - I can [see myself] DEFINITELY trying to convey that message in whatever field that I end up in.”

As professional development. Cameron sees his work with the Graduate Extension Scholars as valuable to his own professional development in two ways. First, it gives him practice with the essential communication skills needed for his future career. “I’m working toward my goal of being a science communicator. Whether that’s education, outreach, Extension, policy, or consulting - anything I end up doing I think it’s helping me be able to articulate my work. Translating the work is difficult.” Second, it enhances his understanding of the applications of his research. “One of the key things for me is the understanding and the connection between the scientific side and the more practical side of my field. I’m stuck in the lab all day. I don’t know how to control some of these things in the real world. Jesse was talking about some of the diseases I study and asking the students about the best control methods in the field and they obviously have more knowledge of that than I do! I think that connection is critical because food is so important and such a hot issue. Having a connection between the practical side and the more esoteric academic side is really important.” In Cameron’s view, having communication skills and a knowledge of the practical applications of his research set him apart from the traditional academic and make him more accessible to the public, an essential asset in industry, advocacy, or policy, and something he personally values being able to do as an academic.
As a social responsibility. In addition to providing career exploration and professional development, being able to participating in the program gave Cameron an opportunity to refine and expand upon his existing ideas about the value of STEM outreach and education. By the conclusion of the program, he identified three significant values of outreach: helping to improve science education, helping to advance community development, and helping to improve public scientific literacy to create a more favorable political climate toward science.

Cameron came into the program with a genuine interest in education as a way to inspire students and share the beauty of the scientific process. However, as Cameron began to work with the Graduate Extension Scholars program he began to share his ideas about education reform. Like many educators, he expressed a negative opinion of the No Child Left Behind Act and was an advocate for more inquiry in science education. He was excited by the possibility that outreach by scientists could advance the quality of K-12 education, enabling more students to experience authentic scientific inquiry. “Working with Jesse yesterday was really cool because he shared my excitement and when I saw his eyes light up I felt like I was enabling someone else. I think that really hits to the root of [the value of this program] – how we can get excitement back in to some of these tired systems.”

By the end of the program, after having participated in a regional STEM education summit and a teacher professional development conference, Cameron was strongly in favor of leveraging outreach and extension activities to assist teachers in providing the best possible quality experience for students through joint programming and teacher training. “... one of my biology teachers [in high school] tried to do some gel electrophoresis with us and it didn’t really resonate with me at all. But HE was the one that set it up and did it, and the students just kind of looked at the apparatus and at the gel at the end. I don’t know why that came to my head. But my
hope is that with a hands-on experience, it could be MORE. And if there was more of this type of collaboration then hopefully he WAS able to find a better way to convey it to his students.”

As Cameron became more immersed in his work with ECHS, he came to see outreach education not only as a way to encourage students to pursue careers in science, but as a way to help the county advance their workforce development goals. “I really want to enable Jesse to teach students some current techniques - things that they could consider useful to get a position. FFA is very vocational. I don’t know the rates, but I’m assuming that some of the students do not go on to college and they would really looking at marketability in Erwin country. How can they get a better work force? How can they get their students to be successful? And I think that, you know, both exciting them in their own fields to care is one half of it. And the other is giving them experience and hands on with current, real-world techniques. And I think that this [outreach program] has a capability to achieve both of those.” Cameron’s appreciation for the possibility that exposing students early on to career-relevant skills in science would enhance their employability persisted throughout the remainder of his experience, especially as he came to see the role of STEM education played in regional development goals through the professional development activities in which he participated.

The researcher joined Cameron on his second visit to ECHS, during which Jesse formally introduced us to the class with which Cameron would be working. A brief introduction to Cameron’s research led into a brief debate about the pros and cons of GMO’s and some of the common public misconceptions about them, facilitated by Jesse. A few days later when I interviewed Cameron, he brought up a previously not mentioned reason for his interest in outreach: “I think as biotechnology becomes more integral to farmer’s everyday lives and professions, it’s important that they understand and have a working relationship with it. And I
think that this project offers a really good jumping off point for them to actually experience and get some hands-on interaction with what their collaborators and people that serve the farming community are actually doing. I want to see if is this project is changing their opinions at all. Is this going be an effective way to get them exposure to biotechnology in agriculture?”

Cameron noted that he felt outreach was an important part of his professional identity because it had the potential to develop a deeper public understanding of scientific issues, which Cameron felt would result in a more favorable attitude toward them. However, it had not previously occurred to him that youth outreach efforts could be part of that attitude change, and that attitude change could be measured. Coming face to face with public misconceptions about his research refined Cameron’s priorities for youth outreach to reflect its broader potential. “The initial goal was to engage students in science, but my new question of “how is this effecting their opinions on biotech?” is the new side. It’s more specific than our original intent – which was to inform students of science to educate them in new techniques.”

4.4.3. Cameron’s Learning Process. Cameron’s learning process was similar to that of his fellow Graduate Extension Scholars in that instruction, experience, application, discourse, and reflection all played key roles. Feedback was less heavily emphasized in Cameron’s discussion of his learning, and though he did occasionally solicit it from the researcher and his community partners, especially at the initial planning and write up stages of module development. However, because Cameron did not explicitly discuss it, it did not emerge as a key theme. One way in which Cameron differed from his peers was in his heavy use of expert consultation in the early development of his educational module. Key themes relating to Cameron’s learning process are discussed in more detail below.
**Instruction.** Some of the key learning outcomes that Cameron claimed to have received from the program included how to engage stakeholders in the outreach planning process and how to engage younger and less-expert audiences. Both of these topics were introduced in the weekly seminar he and his peers attended. As Cameron notes, “[the seminar session on] understanding stakeholders was really important for me. Trying to empathize, trying to get an idea of what they need and what they want was important.” In addition, the program supplemented his learning about the broad structure and function of outreach and extension education, a topic discussed simultaneously in the Graduate Extension Seminar and one of the classes he was taking for his Ph.D. program. “The semester coincided with a class on agricultural science with my PI, and there was a lot of overlap in terms of HOW do we bring scientific understanding into something as fundamental as agriculture?”

It is important to note that Cameron did not enter the program as a “blank slate” in regard to his knowledge of teaching and learning. Rather, the knowledge he acquired through formal instruction expanded and complimented his existing experiential knowledge. Part of what made formal instruction so helpful is that it gave Cameron a language around which to organize his thoughts about education applied to practice. “There’s a lot of stuff [we’re covering in the seminar] that I’ve thought about before but never been able to articulate. [For example], I never used the word stakeholder before. I think that that articulating that concept has really helped me. The other stuff was kind of stuff that I’ve never articulated but I’ve already kind of understood and it was part of my thought process. So, getting it DOWN has helped.”

In addition to giving Cameron a framework to reflect on prior practice, information gleaned during formal instruction through classes and seminars also served as a theoretical and conceptual anchor for ensuing experience. Cameron acknowledged that the combination of
classroom and experience-based learning resulted in knowledge acquisition “[It helped that] my learning about FFA & 4H came simultaneously from an academic perspective and from the ground up, going out and visiting the classrooms.”

**Experience.** According to Schön, “practice is essentially a sequence of problem-solving episodes,” in which practitioners “may use theory, but they have no direct interest in it. Their purpose is to solve the problem that confronts them” (Connelly & Clandinin, 1988, p. 95) When it came to “figuring out” how to teach, Cameron acknowledged the role of theoretical knowledge but emphasized the value of practice and experimentation in learning the technical aspects of effective instruction. For example, regarding his lack of experience working with younger children, Cameron notes that “I know there’s a bunch of resources out there... education texts and things like that, and I’m sure there’s a lot of useful information, but one thing I’ve found with reading stuff like that is that it doesn’t apply every situation. I’d rather experience it for myself.” Though being introduced to ideas of stakeholder analysis, lesson planning, and student engagement strategies through the seminar spurred Cameron’s awareness, he attributes sustained learning to the opportunity to apply these techniques in a real-world setting. “[Through interacting with Jesse and Morgan] I think I HAVE learned how to engage stakeholders. I really want everyone to get what they want out of it. I want to do right by them because they’ve put so much effort into this already and I think that it’s a really good opportunity for our common goals to intertwine.”

Being immersed in the practice of planning, writing, and delivering curriculum also made Cameron aware of misconceptions and knowledge gaps about education that he did not realize that he had. Trying to create an interactive instructional unit that applied his research to the high school setting brought Cameron face-to-face with the relative limitations of expertise and
resources available at ECHS, in spite of their new laboratory and well-funded program. In addition, he realized that exposing students to authentic scientific inquiry at the high school level requires significant effort and planning on the part of instructors as well as school leaders who are funding the equipment needed. “I really enjoy teaching. But the startup energy required is very high. Especially for a lot of this stuff that’s non-lecture based. Both in time and money. You know? This lab cost [ECHS] $300,000. I want other schools to be able to do this, but there’s only three in the state that are equipped to do this. Maybe this will inspire more to at least start thinking about getting their hands into some of this stuff. But even there we saw that they didn’t HAVE all the stuff they needed to do what they originally planned, let alone MY stuff.” As the program went on, this face-to-face experience with the limitations of the high school setting strengthened his initial belief in outreach as a tool for enhancing science education.

Finally, Cameron notes that the opportunity to engage firsthand with high school educators resulted in an expanded understanding of the possibilities for inquiry and knowledge generation at the high school level. “Working with the teachers and having them explain the difficulties, challenges, and REWARDS of that profession. Working in those agriculture classrooms, seeing the ADVANCES from when I was a student. Those were the biggest rewards and the biggest eye openers for me.”

Observation. “I was there watching Jesse’s class. And I guess it wasn’t too different in my own high school experience but there’s kind of shock considering I’ve been in graduate level classes. He had a very relaxed classroom, but given the circumstances it was fine. So I think [in his position] I would have a similar methodology. If kids want to talk, well, I mean they’re high school seniors, you know? This is a vocational class, so whether they’re interested and dedicated - that’s their own prerogative.” Coming into the program, Cameron experienced a learning curve
around classroom management. He was accustomed to a level of discipline and structure from his own high school experience that was evidently no longer “in vogue.” Though he had experienced technology-enhanced learning and laisse-faire classroom management in his undergraduate and graduate studies, he did not expect to find it in the high school setting. After observing Jesse manage his classroom, however, he came to accept this philosophy of classroom management as appropriate.

By the end of the program, Cameron came to value Jesse’s approach to teaching, which involved serving as a mentor and treating high school students as independent, responsible adults. He decided that in the future he would try to incorporate more of Jesse’s teaching style into his own approach. “Watching Jesse teach - he did a lot of “true talk.” He wasn’t there to trick them [into learning] but to say “you know, this is the way it’s going to be and I’m just trying to give you the best shot that I can.” I really respected that. He had this connection with the students so that he could talk to them like they were friends. So I think I would try to emulate some of those things.”

In addition to Jesse, Cameron relied on the Graduate Extension Scholars program coordinator as a role model for teaching. Drawing inspiration from the way in which she facilitated the weekly seminar sessions, Camron came to incorporate a more fluid and open-ended design to his lesson planning. “I've really enjoyed the open ended experience Hannah has provided and [now] I think that the best way to learn is the interaction between the teacher and the student.” He also took to heart Hannah’s repeated emphasis on making sure outreach programming is individualized to the community partners’ needs, ultimately changing his plans to tailor to them. “So [after observing Hannah’s methods] I’ve switched from this idea of lecturing students, having them design and do an experiment... to more what [my community
partners] were thinking - exposing them to a new technique, seeing some of the really cool things that these new techniques allow for and then give them some experience, and fit that as it will into an existing curriculum.”

However, Cameron’s desire to emulate program coordinator’s educational approach was also an occasional source of stress. Hannah modeled discussion-based teaching and dedicated a significant portion of the seminar to discussing various constructivist pedagogies, such as the 5E model for inquiry-based learning, problem-based learning, and design challenges. For Cameron, this set an unspoken expectation that the Graduate Extension Scholars’ modules incorporate these methods. As mentioned in the earlier discussion of Cameron’s learning outcomes, the technical and methodological complexity of his subject matter made it challenging for Cameron to implement the inquiry model to its fullest capacity.

Cameron did not restrict his observations to the immediate program setting. When the program coordinator extended (and funded) an invitation to attend a two-day summit on STEM education being hosted on campus, Cameron took advantage of the opportunity to observe the professional development side of outreach education. This experience exposed him to the logistics of planning outreach and extension efforts on the regional scale, as well as some of the political conversations that surround STEM outreach in terms of its role in workforce development. Cameron’s experience at the STEM summit helped solidify a new vision of outreach education while affirming his career interests: “The kind of stuff that was being said at the STEM summit – this isn’t something that the federal government can mandate and pass down. Its teachers working with their local communities and universities and colleges and farmers that REALLY makes it go. It gave me hope [in this sort of grassroots movement] and it
reaffirmed that I was right to PURSUE a career in education in this field, whether it’s teaching or going into some other advocacy position.”

These burgeoning ideas about outreach education as a professional field were affirmed and expanded upon through Cameron’s participation, along with his fellow Graduate Extension Scholars, in a state-wide teacher professional development event in which they presented the results of their projects. Cameron saw this opportunity as more than another chance to practice his communication skills, but as another window into the field. “[Attending the state agriculture teacher’s conference] really reinforced for me the BENEFIT of [the Department of Agricultural, Leadership, & Community Education] and how partnering with schools and 4H and Extension programs around is– as I said I never knew about any of that before and it really drives a LOT of what’s going on – all the advances and good stuff that’s going on in those programs. I really found it beneficial [to find out] stuff like that is going on even though I had no idea that it was, before.”

Consultation. In addition to observing professional educators, one of the most valuable ways in which Cameron overcame his knowledge gaps around the structure and function of agricultural education institutions was through conversation with his community partners. By asking Jesse (the agriculture teacher) and Suzanne (the 4-H agent) about their role(s), Cameron came to a more nuanced understanding of the differing roles of 4-H and FFA. “Here is a very systematic and widespread group of organizations that have tremendous influence on our everyday lives. I think very few other professions have such a “ground up” approach... I’ve never been to a 4H camp, I’ve seen them on the road, I had no idea what goes on there. I thought [4-H] was like FFA but apparently over a hundred years ago they changed to this more community driven, holistic approach...” In addition to his community partners, Cameron
consulted the program coordinator and the researcher as well as outreach experts outside the program for project ideas, examples, and general advice on how to engage students, simplify information, and organize his curriculum. Overall, interaction with experts drove a significant amount of Cameron’s learning.

**Discourse.** Peer interaction was a critical component of the Graduate Extension Scholars seminar sessions and also served several important roles in Cameron’s learning process. First, because the participants’ academic backgrounds varied, it gave him an opportunity to practice simplifying his ideas for non-experts in his field. Second, the opportunity to hear about his peers’ educational projects without getting bogged down with scientific details was a good opportunity for Cameron to learn from their examples. “The Understanding by Design lessons have really helped with getting us to identify key points without going into specifics. I think it’s allowed everyone to interact, communicate, share ideas.”

In addition to the peer interaction being a learning opportunity in itself, it also served as a reinforcement tool for learning obtained through readings and guest lectures. “I think [the peer interaction] has ENGAGED me to try to understand some of the stuff that we’ve talked about. So I think it’s been a way to facilitate the experience and that all the positives were made MORE positive by having a small group of other students in an informal setting talking and thinking about it.” For Cameron, being able to talk about what he was learning with his peers was a critical motivator and facilitator for learning.

**Reflection.** Over the course of his Graduate Extension Scholars experience, Cameron engaged in reflection in numerous ways and for numerous reasons. Concepts discussed in seminar led to self-reflection on teaching practice “The seminar has done a very good job of helping me logically go through the reasoning behind why we teach certain ways, why we
SHOULD teach certain ways... when we talked about differences in traditional lectures vs. guided learning and hands on stuff it really helped solidify my [new priority] for critical thinking.” Seminar discussions also led to theoretical musing about education in more general terms; “It really gets me thinking. Usually for the rest of the day I’m mulling stuff around in my head.”

Interviews and informal conversations with the researcher gave Cameron an opportunity to reflect on his past experiences and re-evaluate his ideas about education. “You remember how Laurie talked? He was almost adamant about the benefits of lecturing? You know, I had felt that way previously, too, I think.” They were also an opportunity to assess and refine his lesson plans “It doesn’t even have to have the pathogen involved and it fact it may be making it more complicated [CHUCKLES] – that’s the first time I thought about that.” Cameron used the final interview to reflect upon his performance and what he might do differently in the future. “If I had gotten there before SOL week, had an organized thing ready to go, I could have done a little better.” Overall, the Graduate Extension Scholars experience was imbued with opportunities for reflection that facilitated not only Cameron’s acquisition of the technical skills of teaching but the development of his personal teaching philosophy and sense of the value of outreach.

**Application.** “Maybe some of these more theoretical things would be better off in the beginning and we move more of the Understanding by Design modules with specific worksheets and stuff like that to after we’ve already interacted with our stakeholders– and have this more kind of educational theory, evaluation theory– earlier in the course.” Though Cameron appreciated addressing both technical and theoretical content over the course of the Graduate Extension Scholars’ seminar, his feedback regarding the order of topics reflects a significant feature of his learning process – a desire to move logically from theory to practical application.
Due to the abbreviated one-semester timeline of the program, the program coordinator addressed the technicalities of needs assessment, stakeholder analysis, and lesson planning before delving into pedagogical theory.

After addressing educational theory in class and experiencing his site environment first hand, Cameron had a desire to revisit the earlier material to overlay his new contextual and theoretical knowledge. However, he was challenged in doing so due to lack of time and limitations of recall. “I didn’t have time to translate what I learned in those early seminar classes into my outline. We got all these worksheets and it seemed like I was doing things redundantly, going through and filling in the dots. But then after interacting with the teachers and students and getting their opinions I had to go back and re-evaluate all that anyway. So maybe it was good practice, but I didn’t get as much out of it as I could have, initially.”

Cameron felt that the combination of theoretical with practical knowledge resulted in deepest learning, and he expressed a desire to acquire a familiarity with educational theory prior to engaging in practice, in order to have a seamless and logical transition between the two, resulting in more effective application of theoretical knowledge to practice.

4.4.4. Helpful Program Components for Cameron. As was the case with his peers, the formal program structure enhanced and supported his learning in several overarching ways. Specifically, the program community served as a motivator and generator of a social “safety net” in which to explore new intellectual ideas. It also created a “community of practice” in which Cameron could serve as a sort of apprentice to professional educators. Furthermore, the program theoretical framework as well as concrete templates the program director provided helped guide Cameron’s thinking and practice toward various constructivist pedagogies. The ways in which Cameron took advantage of these aspects of the program is discussed in more detail below.
A supportive community. Cameron openly admits that he is charting new waters in the field of agricultural education and at times felt the strain of trying to conceptualize and applying new ideas about teaching and learning in a new classroom setting with limited time to dedicate to the project. One component of the program that kept Cameron motivated to invest in the project and his own learning was the strong social support network formed by his advisor, community partners, fellow participants, and program staff. Cameron primarily found emotional support in his community partners “I was excited because my communications with Jesse had all been positive and his excitement was obvious, even by email. So I think that really helps keep me going.” He was also well supported by his lab group My PI is really excited about this project, too. So when I talked 50/50 about this and my own work [in lab meeting] that was fine with him. I think everyone was even more interested in my Extension Scholar project.” Finally, the researcher served as an avenue through which he could vent frustrations during interviews and informal conversations.

The peer network of the seminar served as an intellectual support network for Cameron – a safe space to freely explore his interests in and ideas about education “it’s ENGAGED me to try to understand some of the stuff that we’ve talked about. I think that it’s been a way to facilitate the experience and that all the positives were made MORE positive by having a small group of other students in an informal setting talking and thinking about it.” The social network of the program also provided accountability. The desire to live up to his community partners’ expectations was a particular motivator for Cameron, who noted that “[Jesse’s] excitement is kind of nerve wracking. He’s excited and almost bragging about me. I don’t want to let him down.” Ultimately, the intellectual support, emotional support, and accountability provided by the program’s community of practice aided Cameron in pursuing his interests in education more
extensively than he would have on his own and motivated him to work hard and thoughtfully on his curriculum development project, therefore maximizing learning.

*Guidance from a theoretical framework.* As the program continued, Cameron began to more heavily emphasize concepts of student motivation and critical thinking in his curriculum plans. Furthermore, he began to make a conscious effort to have experts check his curriculum for the extent to which it engaged students. When I asked him what motivated his interest in stimulating students’ critical thinking skills, he responded, “I think the seminar really has informed and guided the way that I want to teach and the goals that result from it. It’s all stuff that I’ve thought about tangentially but never really sat down and followed through logically. For example, critical thinking – that’s a need in education – you know? To get students to think independently. That’s always been kind of a goal for me, but for example Sidney’s class, where we talked about differences in traditional lectures vs. guided learning and hands-on stuff, really helped solidify my ideas about critical thinking.” In addition to strengthening his emphasis on critical thinking, Cameron credited the seminar with exposing him to the idea of stakeholder analysis, which informed his approach to tailoring his curriculum to meet community needs for the duration of his participation in the program. These were all concepts Cameron had been exposed to previously through experience, but had never conceptualized until given the opportunity to do. The Graduate Extension Scholars seminar curriculum provided a theoretical framework which guided his developing ideas about teaching and learning.

*Templates for practice.* Though Cameron initially spoke skeptically of the lesson planning and stakeholder analysis worksheets provided in the early seminar sessions, he ultimately acknowledged that these structured activities served as useful tools for organizing his thoughts and giving him a template on which to base his lesson planning and partnership
planning efforts. “Having the structure, especially some of those worksheets from the textbook, and getting to think about things like stakeholders that I had never put into words before, gave me a new viewpoint on the way that the program is received and how it affects more than just the students. It was very beneficial and I was able to USE those things. And it didn’t necessarily change any big things that were going to happen IN the module itself, but certainly in the delivery and in the WAY that I could SELL it.” Ultimately, these templates gave Cameron a model for communicating his work as an educator.

4.5. Cross-Case Analysis

Though the experience of each Graduate Extension Scholar was unique, several cross-cutting themes emerged from the analysis of individual cases. Combined findings for the four participants are presented in this section as related to each research question. First, participants’ learning outcomes as observed by the researcher and identified in participant interviews are reported as themes with supporting description and quotes. Second, a description of participants’ evolving motivations for participation and outlook toward outreach are similarly described. Third, Graduate Extension Scholars’ learning and professional identity development processes are summarized, along with individual variations, and are related to the theoretical framework of Kolb’s (1984) experiential learning cycle as well as Lave and Wenger’s (1991) situated learning theory. Finally, critical program components and areas in which the participants felt the program could be strengthened to enhance learning are summarized.

4.5.1. How do participants situate their outreach experience within the context of their professional identities and future goals? Scholar’s motivations for participating in the program were many and varied, though they predominantly revolved around personal professional development and a sense of social responsibility. As agricultural scientists, the
Graduate Extension Scholars felt a sense of responsibility toward outreach. Aiming for careers in academia, most of them were also interested in teaching. However, the Graduate Extension Scholars believed that their formal training offered limited opportunities to develop in the areas of outreach and teaching. Participating in the Graduate Extension Scholars program presented an opportunity to fill these professional development gaps while giving back to their community and engaging in two-way interactions adding to the real-world applicability of their research. As a result of participation, Graduate Extension Scholars’ sense of commitment to outreach was strengthened, as well as expanded to new audiences, settings, and methodologies. The ways in which the Graduate Extension Scholars situated their outreach experience in the context of their professional identities and future goals are described in more detail, below.

**Initial professional identity around outreach.** The GES participants’ career goals reflected a burgeoning identity as public scholars, or at least a recognition that teaching and outreach would be a part of their future professional responsibilities. Of the four participants, Laurie expressed the strongest initial commitment to academia, declaring that “I would like to be a professor in the future because I would like to do research but also I would like to teach.” Sidney also had a fairly strong conception of herself as an educator coming into the program. Having studied horticultural education as an undergraduate, Sidney was also interested in professorship or possibly becoming an Extension specialist. Hayden was more interested in a research career than in teaching, but he did have a strong commitment to public outreach, noting that “[as a scientist] you have to know how to communicate in a non-scientific way. You’ll never go anywhere if you can’t communicate what you’re doing.” Cameron had the least clear career goals but his commitment to public scholarship was evident, noting that “My real passion is
science advocacy. I love the beauty of science and I really want to impress that upon other people.”

Atitudes toward outreach as a professional responsibility. All four participants’ career trajectories into agriculture were strongly motivated by a sense of social responsibility. Laurie noted that, “Since I was a child, there were two VERY clear things in my mind related to my professional career. I wanted to be a researcher and I wanted to do research in order to improve the quality of life for other people.” For Hayden, being an agricultural scientist represented an opportunity to “help [farmers] do a better job and make their WHOLE life more sustainable environmentally and economically,” which was a key motivator for his career choice. Cameron also talked about the opportunity to make a positive social impact by contributing to the control of plant disease and the role of outreach in advancing public knowledge, noting that “as biotechnology becomes more integral to farmers’ everyday lives, it’s important that they understand and have a working relationship with it.” Sidney expressed a similar social commitment when discussing her research, revealing a scientific identity that revolves around the “scholarship of application” (Bagdonis & Dodd, 2010). The commitment of all four participants to outreach and education could be related to their desire to ensure their work had broader impacts beyond the research community.

Initial ideas about outreach. Coming into the program, participants occupied two main “camps” with regard to the purpose and intended audience of outreach. Initially, Laurie and Hayden noted that their conception of outreach from the standpoint of their professional responsibility was more focused on farmer development and the dissemination of agricultural innovations. Cameron and Sidney agreed with Laurie and Hayden, but also expressed somewhat more concern with scientific and agricultural literacy in the general public, and saw youth
outreach as a critical component to advancing this goal. Cameron further pointed out that outreach could help improve science education by bringing “excitement back into some of these tired systems.” All four participants recognized and appreciated the potential opportunity for K-12 outreach to inspire youth to pursue careers in science.

**Motivations for participation.** Participants were attracted to the program primarily as a professional development opportunity. Career-related skills that participants sought to glean from the program included teaching, communication, and program management. They also desired professional exposure to Cooperative Extension or STEM outreach education in general, as well as an opportunity to connect their research to real-world applications. As Cameron noted, “One of the key things for me is understanding the connection between the scientific side and the more practical side of my field.” Hayden, Laurie, and Sidney all spoke to the opportunity to obtain diverse perspectives on their research from the Extension professionals and educators with whom they would be working. Though Hayden recognized that his target audiences would most likely be producers and funders, he saw K-12 outreach as a unique opportunity to grow his ability to communicate with individuals who “don’t have the scientific background I do.” Laurie specifically noted a desire to “to hone my teaching skills” and Sidney felt that “the information on teaching and learning is going to help me be a better professor.” When describing their planned approaches to outreach activities, several of the participants referred to “presenting information” or “giving lectures,” reflecting the direct instruction approach traditionally utilized in higher education, though Cameron and Hayden both expressed a desire to make their teaching more hands-on, and hoped that the program would equip them with the tools to do so.

**Desire to address professional development gaps.** All four participants noted that the GES program provided training and experience that was lacking in their formal programs. As
Sidney noted, “I’d been taught that this is what Extension would do, but I’d never actually SEEN it.” As Laurie noted, training in teaching and outreach “is something that wasn’t present before in our curricula.” Hayden and Cameron agreed with Laurie and Sidney that more explicit training in these areas of professional responsibility beyond research would be helpful. In this regard, participation in the GES program was also an opportunity to explore their future career interests in a way not afforded by the formal structures of their respective graduate programs.

**Opportunity to provide a public benefit.** In addition to professional development, however, participants also saw involvement in the GES program as an opportunity to “give back” to the community in an immediate way by positively impacting youth and helping to improve agricultural education. They also discussed the longer-term benefits of improving scientific and agricultural literacy and advancing farmers’ knowledge of modern agricultural innovations. Coming into the program, Laurie, Sidney, and Cameron all discussed their excitement about the opportunity to potentially serve as a positive role models and encourage youth to pursue higher education. Hayden and Cameron also discussed the potential of the program to improve agricultural education, updating and, as Cameron put it, “getting some excitement back in to some of these tired [educational] systems.” This reflected a prior conception that the agricultural education system was in need of improvement. All four participants pointed out the potential of the program to advance public and practitioner knowledge of current agricultural issues relating to their research. They also pointed out the potential of the program to improve the agricultural workforce by engaging the interest and improving the expertise of youth in agricultural education programs.

**Professional identity affirmation and development.** Though all four Graduate Extension Scholars came into the program with an understanding that teaching and outreach would be a
part of their future professional responsibilities to some degree, participation in the program seemed to enhance participants’ already positive attitudes about outreach and education. Cameron, Laurie, and Sidney, who had expressed initial interest in teaching, reported that their career goals had been strengthened and affirmed. As Cameron reflected, “This experience has made me entertain the idea that academia might be a good career choice, because I enjoy the classroom setting so much. I would love to exist at the interface BETWEEN teaching and research.” Hayden was still not particularly committed to teaching at the conclusion of the program. However, he noted that the novel pedagogical techniques with which the program had equipped him had improved his outlook on teaching, noting that “If it IS a part of what I end up doing, I’ll just think about it more creatively.” Laurie also noted that “teaching for me is [now] more compelling, more fun, because I realized the power I have to influence and impact young people.”

**Changing approach to outreach.** In addition to influencing their attitudes, the GES program also seemed to have an impact on the approach participants might take toward teaching and outreach in the future. For example, Hayden expressed a desire to apply some of the student-centered strategies he’d learned, specifically problem-based learning, to adult farmer development. Sidney also implied a desire to apply her learning to adult education, noting that a “people-centered” approach might also be applicable to project management. Laurie “minimized the idea of lecture” over time, and became more open to incorporating more hands-on activities. Sidney, Cameron, and Hayden also expressed a desire to continue to improve their understanding of and ability to incorporate inquiry-based models into their teaching. They also began to discuss the importance of incorporating career connections into educational content. The data therefore suggested that participants emerged from the GES program with a more student-centered and
experiential teaching style which they desired to apply all levels, reflecting the reported values of 4-H and school-based agricultural education (Baker, Robinson, & Kolb, 2012; Bourdeau, 2004).

**Expanded ideas about outreach.** The program also seemed to influence participants’ conceptions of the goals and target audience for outreach. Hayden, who had previously described the primary purpose of outreach to be farmer development, came to see youth outreach as complimentary to this goal, noting that “*there’s a back door we have with high school students. Not only will they think about it for when they take over the farm but they’ll also go home and tell their parents.*” It should be noted that this perspective is well-aligned with the original goals of the 4-H and FFA programs (Talbert, 2007a, 2007b). Indeed, Laurie desired to shift his focus to outreach at the elementary level because “*I think we can impact young kids to a greater extent, so if we want to make a HUGE impact [on recruiting more people into agriculture] we need to target younger students.*” In addition to youth, Cameron and Hayden identified agricultural educators as an additional important target audience for outreach. Both specifically expressed a sense that scientists could play a role in supporting the work of agricultural educators by helping them stay abreast of the most up-to-date research. As Hayden noted, “*we need to increase support for teachers and get more graduate students or professors to write curriculum.*” Overall, the program expanded all four participants’ conceptions of possible avenues for outreach partnership. As Laurie concluded in his exit interview, “*I never thought about working with schools. Now I see we can connect if we have the desire, the time, and the resources.*”

**Increased commitment to outreach.** Overall, participants expressed a desire to persist with or increase their future involvement with teaching and outreach at the conclusion of the program. Laurie was the most enthusiastic in this regard, extending his relationship with his GES
partners well into the summer and fall following the initial pilot program commitment and expressing an interest in continuing his outreach activities for the duration of his Ph.D. program. As he noted, “I feel that [with youth outreach] I’m contributing to society to a greater extent. I’m not just thinking about people with a connection to agronomy.” In addition to being committed to continuing with outreach, themselves, the participants also developed an interest in encouraging others to pursue outreach opportunities and advocating for the expansion of outreach professional development for graduate students. Though dissemination of their curricula at the [State] agricultural educators meeting was a program requirement, Sidney, Laurie, and Hayden all took advantage of additional dissemination opportunities. Hayden described his motivation for presenting on his GES project at an agronomy-specific conference well after the program’s conclusion as follows, “I want to spread the word. I think it’s a great model and I want other people to get on board.” Overall, these intentions represent an emerging sense of “outreach advocacy” among participants in the Graduate Extension Scholars program.

4.5.2. What perceptions and skill/knowledge gaps do participants have about outreach education before and after participating in the program? The Graduate Extension Scholars program reported diverse learning outcomes from participation in the program, including an increased confidence in their teaching abilities and abilities to simplify scientific information for lay audiences. They also expressed appreciation for the exposure to pedagogical techniques and terminology with which they were previously unfamiliar. Finally, participants displayed a more sophisticated understanding of the form and function of the Cooperative Extension and public education systems. Participants indicated that this understanding would be helpful to them in future projects and collaborations. A summary of learning outcomes and lingering questions as related to initial knowledge gaps for all four participants is provided below.
Structure and function of K-12 agricultural education programs. Participants came into the Graduate Extension Scholars program with limited knowledge of the structure and function of K-12 agricultural education programs. They had little to no prior experience with the youth development arm of Cooperative Extension system (4-H) or the school-based agricultural education program (SBAE). Only Sidney had previously worked with either of these organizations, having assisted with campus-based FFA summer programs while working on her undergraduate degree. Over the course of the program, participants developed a deeper understanding of their respective purposes as well as the scope and scale of their work. Particularly, Cameron developed a sense of the respective goals of 4-H and school-based agricultural education around character-building and workforce development, respectively. He also reported developing a better understanding of the management and leadership of informal and school based agricultural education, including an appreciation for the role of the Department of Agricultural, Leadership, and Community Education in coordinating agricultural education activities statewide. Laurie was particularly impressed with the extensive history and national prevalence of the 4-H and FFA organizations and expressed a desire to help replicate them in his home country of Argentina. Sidney came to appreciate the motivating effect hands-on learning of the sort offered in SBAE programs could have on students who normally struggled to engage in school, noting that “some of the high school students really get into the FFA program and I think it’s one of the things that gets them interested enough that they want to go on to college.”

Public roles and skills of K-12 agricultural educators. In addition to acquiring an improved sense of the structure and function of agricultural education institutions, participants’ interactions with agricultural education professionals gave them an enhanced sense of their teaching expertise and their public roles beyond instruction. For example, Cameron’s community partners were
deeply involved in county-wide economic development efforts, which helped him see how school based agricultural education could compliment regional workforce development planning. Sidney noted that, in “talking to teachers, I got more information about how they’re trying to use social connections to improve their own classrooms,” resulting in similar recognition of the agricultural educator’s role as a community collaborator. For Laurie, the experience resulted in a new appreciation for the myriad skills that educators need above and beyond content knowledge, such as classroom management and interpersonal skills. As he noted, before participating in the GES program, he “sort of underestimated the job that teachers have. I have much more consideration for teachers now.” Though Laurie was able to work closely with his partnering 4-H agent, Cameron, Sidney, and Hayden ran into issues with their partnering 4-H agent being too busy to participate fully in instructional module development. However, they did have the opportunity to visit their partner’s programs and discuss the roles and responsibilities of the 4-H agent position. Hearing about their work, and in Laurie’s case witnessing it, gave all four participants a better sense of the 4-H agent’s extensive role in the community. As a result of this improved understanding of their roles and responsibilities, all four participants reported that their empathy and respect for agricultural educators had increased significantly.

Program planning. One of the priorities of the Graduate Extension Scholars program was to introduce participants to the program management skills they would need to implement sustainable high-quality outreach activities in the future. None of the four participants had any prior experience with program management or planning. Topics to which the Graduate Extension Scholars were introduced included federal broader impacts expectations, program planning, stakeholder engagement, and program evaluation. In particular, stakeholder engagement and the negotiation of project objectives were focal points in the Graduate Extension Scholars’
discussion of learning outcomes. As Cameron noted, “I had never used the word ‘stakeholder’ before. I think that understanding that concept has been the biggest help. I think I HAVE learned how to engage them. I really want everyone to get what they want out of [this project].” In many cases, participants described going through an “adjustment period” during which the format and content of their instructional module shifted and changed based on their evolving understanding of their partners’ desires for the program. The Graduate Extension Scholars were sometimes challenged to balance the needs of their respective partners and the program’s goals.

Furthermore, their participation in research activities gave them some perspective into the effort it might take to manage a larger scale project. At the conclusion of the program, Hayden and Laurie specifically expressed increased confidence in being able to prepare compelling broader impacts components of future research proposals. Sidney and Hayden also commented on how the experience had helped them see how they might operate as consultants or managers on future Extension projects, and Cameron noted that he felt better equipped to navigate the professional world of science outreach, in general. However, the Graduate Extension Scholars also pointed out that the program’s coverage of program evaluation was insufficient for them to develop a functional understanding of the process and recommended that future iterations provide more opportunities for participants to be involved in assessing the outcomes of their efforts in schools and 4-H clubs.

**Constructivist pedagogical methods.** Coming into the program, the Graduate Extension Scholars were unified in their desire to improve their teaching skills. Most participants cited simplification of scientific information as their primary area of improvement, though Hayden did indicate a desire to make his teaching more “hands-on.” At the conclusion of the program, the Graduate Extension Scholars reported increased confidence and competence with a variety of
new teaching methods in addition to an improved ability to simplify scientific information. As Cameron noted, “thinking long and hard about ways to get students to think creatively on their own, both in the seminar and while trying to develop my module, was really beneficial to my understanding of how to educate in that [inquiry-based] way.”

Most of the Graduate Extension Scholars reflected that their primary teaching style before participating in the program had been more lecture-based than they had previously realized, but they became more oriented toward experiential and inquiry-based methods over time in the program. Describing how he might modify his teaching style moving forward, Hayden showed what he had learned, stating that “I would give students more responsibility for calculating things and doing real-world type problems instead of just expecting them to regurgitate information.” Upon concluding the program, Sidney and Hayden reported believing that their understanding of how to use questioning to effectively engage student thinking and reinforce previous concepts had improved. All four participants reported feeling better able to reduce the complexity of scientific content. Though the Graduate Extension Scholars were all to a certain extent natural teachers, over successive visits, all four appeared to become more comfortable working with youth. Laurie, in particular, showed the most improvement in his ability to simplify scientific information, having started as a very technical and lecture-oriented instructor but moving toward a more hands-on approach with less emphasis on technical information.

One additional unexpected outcome in regard to constructivist pedagogy was an acknowledgement on the part of all four participants that the teacher-student relationship plays a significant role in students’ motivation to engage and ability to learn. As Hayden and Laurie also noted, even the most engaging lesson plans could be difficult to implement if a trusting
relationship did not exist between the teacher and students. As Sidney concluded, “Education isn’t just presenting information. A lot if it is finding ways to connect with the other person.”

Curriculum design and description. As mentioned previously, the central planning activity in which the Graduate Extension Scholars engaged was the development of an instructional module. In addition to piloting the module in their partners’ classrooms or at 4-H club meetings, participants were expected to produce a final write-up of their lesson plans for the program website. They were also encouraged to disseminate the results of their curriculum design efforts at a regional teacher’s conference and/or another venue of their choosing. The Graduate Extension Scholars had limited prior experience with lesson planning as teaching assistants, but reported that most of the lessons they delivered as TA’s had been previously developed by the lead instructor. None of the Graduate Extension Scholars had ever written curriculum for publication or presented on an education-related project.

The process of designing, testing, and disseminating the results of their instructional modules gave the Graduate Extension Scholars new insights into curriculum design and description. In particular, Hayden pointed out that the writing process helped him learn how to plan classroom interaction, “I was able to sit down and think about what questions to ask and in what order.” Participants were exposed to student-centered pedagogical approaches with which they were previously unfamiliar, such as the Understanding by Design framework and the “5E” instructional model for inquiry-based learning (Bybee et al., 2006; Wiggins & McTighe, 2005). With these tools available, all four participants reported feeling better able to organize lessons in the future. They also expressed an interest in learning more about the aforementioned curriculum planning structures so that they could incorporate them into future lesson planning endeavors. However, the Graduate Extension Scholars also acknowledged and came to embrace uncertainty
in lesson planning, as students’ questions taking their curricula in new and unexpected directions during delivery sessions. Cameron, in particular, commented on the importance of leaving written curriculum structured enough that teachers could understand the essential message, but flexible enough that the teacher could modify it to his or her needs. Laurie and Sidney also discussed learning the importance of being flexible in the light of unexpected classroom occurrences.

**Academic Communication.** In addition to improved lesson planning and curriculum writing skills, participants also cited enhanced communication skills from participation in curriculum dissemination activities. Sidney and Hayden commented on the benefits gleaned from additional presentation opportunities. Further, Sidney and Laurie took advantage of the opportunity to practice poster preparation and presentation at an additional conference not attended by Hayden or Cameron. This was Sidney’s first poster presentation, and she therefore considered it a very helpful learning experience in how to create and present a poster.

**Scientific Skills.** One final unexpected outcome for the Graduate Extension Scholars program was not related to teaching at all, but to the participants’ development of research skills. As mentioned previously, Laurie developed an enhanced interest in social science research as a result of his involvement in the program and felt he was leaving the program equipped with some basic skills on which to build further when exploring public perceptions of his research area. In the process of preparing his poster for presentation, Laurie was particularly struck by the difference between scientific and social-scientific research, noting that it entailed “a quite different approach. You’re no longer measuring a number but a PERCEPTION and that means you have to look at the way people BEHAVE.” This brief introduction to the social science of agriculture piqued his interest in incorporating socio-scientific questions into his future research.
For Sidney, whose research already involved a socio-scientific question, interactions with the researcher provided her with an opportunity to explore methodological options. Hayden came to appreciate the benefits that outreach could have for his basic scientific understanding, noting that “Talking about inquiry-based learning took me back to the basic principles of the scientific method and was a refresher why we have controls and what we’re trying to figure out.”

Cameron unexpectedly found himself having to devise a modified approach to a standard biotechnological procedure in order to make it more affordable and accessible to a high school audience with limited resources. This forced him to exercise resourcefulness and gave him valuable experience with procedure design.

4.5.3. How do participants work through their perceptions and knowledge gaps around outreach education as they progress through the program (i.e. learn)? As mentioned previously, in addition to describing the learning and professional identity outcomes experienced by the Graduate Extension Scholars, this study sought to describe the processes by which participants achieved these learning and professional identity development outcomes. The lenses of Kolb’s (1984) experiential learning cycle and Lave and Wenger’s (1991) situated learning theory were employed to describe skill/knowledge acquisition and professional identity development, respectively. The section that follows connects evidence of participants’ learning processes to description of these respective theories. A summary of program components supporting experiential and situated learning is provided below.
Evidence of constructivist experiential learning. Kolb’s experiential learning cycle consists of continuous movement through four adaptive learning modes; concrete experience, reflective observation, abstract conceptualization, and active experimentation (Abdulwahed & Nagy, 2009; Clark et al., 2010; Kolb, 1984). Knowledge is grasped through abstract conceptualization (comprehension) or through concrete experience (apprehension) (Kolb, 1984). Together, these two modes of knowledge acquisition form the “prehension” dimension of the learning cycle, which sets the stage for knowledge transformation (Abdulwahed & Nagy, 2009; Kolb, 1984). Transformation, also referred to as knowledge construction or application, occurs through reflective observation (intention) or active experimentation (extension) (Abdulwahed & Nagy, 2009; Clark et al., 2010; Kolb, 1984). As Kolb (1984) notes, “during the process of learning, one moves in varying degrees from actor to observer, and from specific involvement to general analytic detachment” (p. 31). As described in Chapter 2, participants indicated movement through various learning modes throughout the program. Furthermore, participants’ descriptions
of their learning processes indicated that different learning outcomes were achieved via different learning modes. Participants’ movements through the four modes of Kolb’s (1984) learning cycle and their declared relationship to various learning outcome described above are described in more detail for the four Graduate Extension Scholars as a group in the following sections.

*Concrete Experience.* As an exercise in experiential learning, the Graduate Extension Scholars was founded on practical experience in the activities of agricultural science outreach education, including curriculum planning, design, and delivery as well as participation in professional development activities of the STEM outreach and agricultural education communities through attendance of outreach and agricultural education conferences for dissemination of the program’s work. As Kolb (1984) notes, learning in the concrete experience mode requires the ability to involve oneself “fully, openly, and without bias in new experiences” (p. 30). Engagement in all of these activities could be considered concrete experience of outreach education. In addition, participants’ prior experiences with teaching and outreach activities provided a foundation from which they further built their knowledge. The Graduate Extension Scholars frequently referenced their experiences as significant learning opportunities. Particularly, initial site visits in which participants observed their partner educators gave Graduate Extension Scholars an important initial sense of the “hands on” approach to agricultural education as well as a sense of the secondary, and in Laurie’s case elementary, classroom environment. As Cameron notes, this experience allowed him to grasp what was expected of him in this new educational setting and gave him an example from which to work. This acknowledgement was explicitly reinforced by Sidney but seemed to play a role in all four participants’ learning, based on the researcher’s observations. The role of concrete experience was not limited to interaction with community partners. As Cameron, Sidney and Laurie all
explicitly noted, the environment of the seminar was an experience in itself, unlike their prior experience as students. The modeling of constructivist pedagogy in seminar further aided them in grasping what student-centered teaching might look like.

**Reflective Observation.** According to Kolb (1984), the process of reflective observation involves reflecting on prior experience or actively observing one’s experience from various perspectives. The Graduate Extension Scholars frequently referenced reflection on or “thinking about” their outreach and teaching experience. They often compared their prior experience to the experience of the program, noting similarities, differences, and points of growth. The Graduate Extension Scholars showed evidence of incorporating others’ perspectives on education into their reflections on prior experience. For example, Cameron references Laurie’s perspective on direct-instruction when reflecting on his own previous approach to teaching when he notes that “You remember how Laurie was almost adamant about the benefits of lecturing? I had felt that way previously, too.” Laurie mentions beginning to “wonder if my approaches are right or not” after exposure to new ideas in seminar. Hayden refers to looking back on his prior teaching “to see what I did wrong and what to apply” and reflecting on his performance “I was kind of hoping it would flow naturally, and it did, but that probably wasn’t the best course for learning.” All of these examples point to the Graduate Extension Scholars’ use of reflection to make meaning of their experiences. As Fenwick (2003) points out, feedback conversations between the learner and instructor, such as those that occurred between the Graduate Extension Scholars and the researcher or program director about their curriculum writing and delivery, are also a method of reflective observation.

**Abstract Conceptualization.** As Kolb (1984) notes, the abstract conceptualization mode of learning involves integrating observations into logically sound theories. Feeding off of reflective
processes, Sidney and Laurie showed evidence of abstract conceptualization when they discussed their conceptualization of the reasoning behind various constructivist approaches. For example, Sidney connected her observation of Kendall’s lack of behavior management problems to the student-centered approach to teaching, noting that “it makes me wonder if there’s some connection to students acting out in other classes and [Kendall’s] teaching style that allows the students to be a part of the lesson.” She further extended this theory to adults, noting “Say you’re having problems with an employee. If you change your management style with that person will they clear up?” Similarly, Hayden began to postulate whether problem-based learning could be applied to adult Extension education to encourage inquiry in the same ways it did for high school students. Furthermore, as Cameron noted, conceptualizing the process of stakeholder analysis helped him be more empathetic to his community partners, whereas Laurie and Sidney adapted the abstract concept of the 5E learning model to lesson development into their own style of lesson development.

*Active Experimentation.* Described by Kolb (1984) as the ability to use theories developed through abstract conceptualization to make decisions and solve problems, active experimentation was probably the most frequently activated stage of the learning cycle employed by participants and observed by the researcher. This was exemplified by the way in which Graduate Extension Scholars modified their teaching approach over the course of successive site visits and increasingly extended time spent in seminar discussing constructivist pedagogical techniques. For example, Hayden successively increased his classroom questioning, Sidney incorporated a competition, and Laurie and Cameron toned down the technicality of their activities for younger audiences. These actions all represent the manipulation of their practice to incorporate new knowledge acquired via the aforementioned modes.
For participants who had repeated opportunities to deliver curriculum, namely Hayden and Laurie, new approaches were tested, then reflected upon and analyzed to assess their effect. Successive visits resulted in further modification, accordingly. This represented the true completion of Kolb’s cycle in iterative fashion. One of the drawbacks of the program was the short timeline, which inhibited Cameron and Sidney from delivering multiple lessons over time and which even Laurie and Hayden recommended extending. The Graduate Extension Scholars felt that more time would allow them further opportunities to experiment and apply what they had learned to see what worked best for them as educators.

**Evidence of situated experiential learning.** As discussed in Chapter 2, situated learning describes how novice members of a community of practice move toward full or “expert” membership, via “legitimate peripheral participation” (Lave & Wenger, 1991). In legitimate peripheral participation, learning occurs through observation of and participation in the activities of the community as well as interaction with both experts and peers (Lave & Wenger, 1991). The learner’s identity as a community member is legitimized through affirmation from experts and peers (Lave & Wenger, 1991). Membership is guided and symbolized, or reified, through the use of the community’s unique language or manner of discourse as well as the adoption of models and templates for practice unique to the community (Lave & Wenger, 1991). Over time, through successively more significant engagement in the practices of the community and through and social interaction with expert members, the participant not only begins to incorporate community membership into his or her self-concept, but also begins to act and speak in accordance with the community’s norms, values, and standards of practice (Wenger, 1998). In the context of the Graduate Extension Scholars program, participants were considered to be engaging in legitimate peripheral participation in the community of agricultural education with the objective of
contributing to a “boundary” identity as “scientists-educators,” which would increase their commitment to public scholarship in the form of outreach education. The professional identity outcomes described above demonstrate evidence of movement toward a stronger boundary identity in the form of increased commitment to outreach and an enhanced sense of the possibilities for K-12 partnership for themselves as agricultural scientists. Evidence of the Graduate Extension Scholars’ engagement in legitimate peripheral participation is summarized, below.

Observation. As mentioned previously, the experience of observing their community partners was a significant learning opportunity for the Graduate Extension Scholars. Observation did not only provide experiential grounding for the practice of teaching, it also provided participants with models for professional practice (Pratt, 1998). For example, Cameron spoke to how observation of Jesse’s teaching influenced his own conception of himself as a teacher, “Watching Jesse teach - he did a lot of “true talk.” I really respected that. He had this connection with the students so that he could talk to them like they were friends. So I think I would try to emulate some of those things.” Hayden and Sidney also referred to observing their partner teachers for insights, and Laurie took his observation a step further by taking advantage of the opportunity to observe the program director conducting an outreach activity, as well. Additionally, Sidney’s observations of the program director in the context of program management and the conduct of the seminar provided her with a role model for professorship. These observations could be considered the Graduate Extension Scholars’ first look into the “culture of practice” (Lave & Wenger, 1991, p. 95) of agricultural education.

Interaction. As Sidney noted, “A lot of [learning] was just in interacting with other people – things they said, things they mentioned happening to them, or in talking to the teacher.”
You learn things that you didn’t expect to learn.” As Lave and Wenger (1991) note, the social relations of learners within a community are an important way in which they come to understand the culture of practice. As the Graduate Extension Scholars repeatedly interacted with their community partners and other agricultural and STEM outreach education professionals, they built increasingly upon their understanding of the structure and function of agricultural education as well as the roles of agricultural educators in their communities and he industry. It was from this interaction in the context of his partner site visits and attendance of one of the professional conferences to which the program director invited the Graduate Extension Scholars that Cameron came to appreciate the wider social net that constituted the outreach education community and the role of the land-grand university as a convener and facilitator of statewide outreach and agricultural education activities. Interaction with educators also represented a coming to know them as individuals and professionals, leading to enhanced respect for them as individuals and their professional work. As Laurie noted, “Mainly by experience [working with my partners]… I have been tearing down the walls I envisioned between these two communities [K-12 and higher education].” This sentiment was echoed by all of the Graduate Extension Scholars and indicates that the participants’ community partners served as exemplars of educational practice.

Participation. The central and critical component of the Graduate Extension Scholars program was, of course, the opportunity to participate in authentic outreach program planning activities through the development and piloting of an educational module. This activity presented an opportunity to engage in active experimentation with the ideas about teaching participants had learned through prior experience, observation of their partners, discussion in seminar, and elsewhere. However, it also offered an opportunity “to make the culture of practice theirs” (Lave & Wenger, 1991, p. 95), and apply what they had been learning about how agricultural educators
approach the teaching process. This activity was well received by the Graduate Extension Scholars as perhaps the most informative because it brought them face to face with the challenges of student engagement and classroom management, forced them to modify approaches and techniques to suit the resources and level of expertise of their community partners, and gave them an opportunity to “put theory to practice” to see what was really meant by classroom questioning or inquiry.

In keeping with the premise of legitimate peripheral participation, the Graduate Extension Scholars’ participation was limited. They were not responsible for seeking out their community partners, nor were they expected to assess student learning. The scope and scale of their project was much smaller than the type of broader impacts program they might be expected to manage in the future. However, this was where interaction; with seminar guest lecturers, the program director, the researcher, and other professionals to whom they were introduced at educational conferences, filled in some gaps. The Graduate Extension Scholars did note, however, that they would have liked to be more involved in additional aspects of outreach programming, specifically project evaluation and assessment of student learning. They pointed out that these two topics were addressed in the seminar’s instructional activities, or “teaching curriculum” (Lave & Wenger, 1991, p. 95) of the program but they were not given opportunities to practice with them and therefore did not feel they had developed a sufficient understanding. The Graduate Extension Scholars recommended that those elements be incorporated into the “learning curriculum,” (Lave & Wenger, 1991, p. 95) or practical activities of the program in the future to provide a more complete view of the practice of outreach education, or “broad access to the arena of mature practice” (Lave & Wenger, 1991, p. 110).
Affirmation. As Lave and Wenger (1991) note, “acceptance by and interaction with acknowledged adept practitioners makes learning legitimate and of value from the point of view of the apprentice” (p. 110). In the context of the Graduate Extension Scholars program, this affirmation was represented by the relationships participants built with their community partners as well as with the researcher and program director. Fenwick (2003) and Pratt (1998) point out that coaching is an important role for the “master” or instructor in situated learning to play. The provision of coaching and feedback, as Lave and Wenger (1991) point out, is a form of acknowledgement necessary for effective situated learning. From the standpoint of the situated perspective, therefore, the feedback processes in which the Graduate Extension Scholars engaged with their community partners, the researcher, and the program director served not only as a facilitator of learning but as a motivator and mode of membership in the community of practice.

An interesting incidence of the importance of affirmation occurred in Laurie’s case. Seeing the program director as the primary “acknowledged adept practitioner” in the program’s social system, he was dissatisfied with only receiving on-site coaching and feedback from the teachers and the researcher. One of his suggestions for program improvement was to have the program director more involved in providing just-in-time assistance to participants during their on-site teaching activities. His example shows how the process of affirmation is closely tied to the power relations inherent in the community of practice and indicates that the learners’ analysis of the community’s power dynamic has implications for his or her impression of the legitimacy of the learning experience.

Models & Templates. Another important aspect of legitimate peripheral participation, as Lave and Wenger (1991) note, is the apprentices’ ability to understand and employ the artifacts and technologies of the community of practice. In the context of the Graduate Extension
Scholars program, standard curriculum planning models like the Understanding by Design framework, the BSCS 5E model, or the 4-H curriculum design template could be considered artifacts of the K-12 education community which help guide the practice of curriculum design. Familiarity with these models and templates is therefore an important aspect of the Graduate Extension Scholars’ learning. As Hayden and Sidney noted, these artifacts proved as helpful organizing tools for themselves as novice practitioners to replicate what a professional educator might do. However, as Cameron and Laurie pointed out, their use of these templates was somewhat limited. For Laurie this was due to the fact that they were difficult to interpret on such a short time frame. In Cameron’s case, his use of formal curriculum templates was inhibited by a lack of motivation – it was not required or reinforced specifically by the program director. The role of models and templates for the practice of curriculum design therefore varied based on the individual participants’ motivation and feeling of need to use them.

Discourse. A final element of legitimate peripheral participation, as Lave and Wenger (1991) point out, is “the process of learning to speak as a full member of a community of practice” (p. 106). Conversations, stories, and other ways of talking within practice (exchanging helpful information relating to the progress of ongoing activities) and about practice (stories, lore, instruction) are an important aspect of newcomers’ participation (Lave & Wenger, p. 109). Thorough conversation with their community partners, with one another, with the program director, and with the researcher, the Graduate Extension Scholars were exposed to a variety of perspectives on current educational issues and modes of thought, exposing them to the discourse of the field, thereby learning to talk as educators. As Hayden and Sidney noted, the opportunity to talk about their curriculum planning activities with peers gave them an opportunity to learn from one another and exchange helpful “tricks of the trade.” Furthermore, for Cameron and
Laurie, the opportunity to debate educational theories and issues on a philosophical level was an important way to access the educational community from an academic standpoint, or as Cameron noted “[the peer interaction] has ENGAGED me to try to understand some of the stuff that we’ve talked about.” Cameron’s adoption of the term “stakeholder,” Hayden’s increasing reference to “inquiry,” and Sidney and Laurie’s references to using “the E’s” are evidence of the Graduate Extension Scholars’ adoption of the language of the educational community, symbolizing movement toward membership (Lave & Wenger, 1991).

**Limitations to constructivist & situated learning models.** It should be noted that though the Graduate Extension Scholars did appear to engage in many of the aspects of Kolb’s (1984) experiential learning cycle as well as Lave and Wenger’s (1991) situated learning model, there were aspect of the Graduate Extension Scholars’ experience that were not sufficiently addressed by either of these models. In particular, the role of seminar instruction – consisting of the program director and guests’ lectures, guided discussions, and assigned readings about constructivist education and outreach education in general – is overlooked in these experiential models. Based on the Graduate Extension Scholars’ feedback, however, this element was an important component that assisted in their ability to make meaningful connections between their experience and the theoretical foundations of the field of agricultural education. As Hayden noted, “The seminar helped me to strive towards [inquiry] and gave me some practical direction [of ways to engage students].” Instruction seemed to give participants the requisite prior knowledge to guide their experimentation in the classroom and may have played an important role in prehension. The theoretical orientation of the seminar toward constructivism also seemed to influence the Graduate Extension Scholars’ own teaching styles over the course of their experience, as all four of them seemed to have “bought in” to the idea of hands-on and inquiry-
based learning by the conclusion of the program. Further investigation according to a different theoretical framework might have shed additional light on the importance of instruction and appropriate instructional methods for graduate students engaging in this type of professional development experience.

4.5.4. **What significance do participants assign to various social, pedagogical, and experiential components of the program with regard to learning and professional identity development?** Overall, the Graduate Extension Scholars appreciated the experiential nature of the program and the combination of formal instruction through seminar and unstructured experience through their community partner work. There were two key ways in which a formal program structure enhanced participants’ learning – by providing social support and structural support. The former served as a motivator and generator of a social “safety net” in which to explore new intellectual ideas. It also created a “community of practice” in which participants could serve as apprentices to professional educators. The latter helped participants maximize their learning by attending to each stage of Kolb’s experiential learning cycle; engaging intentionally in abstract conceptualization and active experimentation while also encouraging reflection on both abstract learning and concrete experience. The following section discusses the ways in which the program structure supported the Graduate Extension Scholars’ experiential and situated learning in more detail.

**Support for experiential learning.** As lifelong students, the Graduate Extension Scholars were accustomed to engaging the abstract conceptualization and reflective observation phases of Kolb’s cycle through theoretical coursework, which is predominantly situated along the assimilative dimension of Kolb’s cycle (see Figure 2) (Abdulwahed & Nagy, 2009). The Graduate Extension Scholars also had prior concrete experience with teaching and learning as
students and educators in various capacities, having engaged in active experimentation with teaching methods through their work as teaching assistants and in other teaching roles. However, what they had lacked previously was an experience that explicitly engaged all four of the phases of the learning cycle in conjunction, which as Abdulwahed and Nagy (2009) assert provides the optimal condition for learning. Participating in a structured program gave participants the opportunity to move through all four stages of Kolb’s cycle in an intentional way.

In particular, participants appreciated the opportunity to engage in some prehension, or knowledge acquisition through experiential observation and abstract conceptualization, before being expected to apply this knowledge by experimenting with teaching on their own. This phase was accomplished in the context of the Graduate Extension program in three ways, through instruction in the seminar, through observational site visits, and through interaction and discussion with their peers, the program director, and other advisors and educators with whom the Graduate Extension Scholars consulted. Specifically, participants appreciated the way the seminar was reflective of the program director’s expectations for their teaching. As Laurie noted, “There is a connection between what we are supposed to do and what we are doing in seminar. If we talked about flow, flexibility, and open ideas, but we didn’t have them [in seminar], it wouldn’t work.” This finding reveals the importance of considering the desired learning and performance objectives when constructing learning environments for the study of teaching and learning.

An additional helpful feature of the program structure was technical support from the program director and researcher. The opportunity to receive feedback from these individuals and others on their curriculum plans and lesson delivery was a critical component of the program for participants. In particular, the researcher’s attendance of site visits to provide feedback, though
originally unplanned as a formal program component, emerged as particularly helpful. The Graduate Extension Scholars strongly encouraged the program director to maintain this support structure in future iterations of the program either through her own attendance of site visits or the recruitment of a full-time graduate assistant to support the program. As Fenwick (2003) points out, providing feedback and encouraging self-assessment is an important role for facilitators of constructivist experiential learning.

Finally, the discussion-based nature of the seminar helped to facilitate reflection on prior experience, current successes and challenges with the Graduate Extension Scholars’ respective module development projects, and theoretical considerations of the constructivist perspective. As Sidney notes, “When you hear from a different perspective, sometimes you’ll hear something that you didn’t notice, yourself.” Based on the researcher’s observations, the nature of conversation in seminar and interviews was highly reflective. Scholars frequently used this time to recall past experience and identify areas for improvement and aspects of their experience which were applicable to what they had been learning in the instructional portion of the Graduate Extension Scholars seminar.

**Limitations to experiential learning.** The order in which program activities were conducted somewhat affected the Graduate Extension Scholars’ ability to move smoothly from prehension to transformation, however, in the application of their learning to their lesson planning and delivery experiences. Participants appreciated receiving instruction on lesson planning via various constructivist approaches. However, due to the short timeline of the program, the need to begin planning preceded participants’ study of various possible approaches to lesson planning. Furthermore, as Cameron noted, because lesson planning began before participants had a chance to visit their sites and evaluate the resources and needs of their partners, they had to “go back
and re-evaluate all that anyway.” Based on their later learning in seminar and through interaction with partners, the Graduate Extension Scholars made some revisions to their curricula, but a lot of what they learned in seminar simply had to be “saved” for a later site visit or a future teaching experience. A suggestion for improvement on which all four Graduate Extension Scholars concurred was to provide context for the program’s constructivist/experiential theoretical framework, examples of relevant pedagogical approaches, and an opportunity evaluate their partner sites prior to commencing planning for their educational modules.

The Graduate Extension Scholars appreciated how the majority of topics were addressed through a complete iteration of Kolb’s cycle, combing abstract conceptualization through reading and seminar discussion, experience in the form of observation, and experimentation in the form of application of learning to authentic tasks. However, some topics were only addressed from an theoretical perspective, and participants were never given a chance to experience or apply their learning. Specifically, participants expressed some disappointment that they never had an opportunity to practice with assessment of student learning and evaluation of their programming efforts. These topics were discussed in seminar but the short timeline of the program prevented their application to the Graduate Extension Scholars’ work. An additional suggestion for improvement that the Graduate Extension Scholars provided was to extend the timeline to give participants an opportunity to practice with assessing and evaluating their efforts, independently. Specifically, participants expressed a desire to have an opportunity to evaluate their efforts based on feedback from community partners and program leadership, assessment of student learning, and their own self-assessment. Then, participants would have liked to revise their educational
modules accordingly and deliver them, again, to evaluate whether their revisions had resulted in improvement, thus completing multiple iterative cycle of experiential learning.

**Support for professional identity development.** As mentioned previously, identity development, according to Lave and Wenger (1991) necessitates authentic engagement with the expert practitioners and activities of a community of practice. Aspects of the program which participants found particularly helpful in their professional identity development included (1) the opportunity to interact with professional educators in the context of the seminar and their module development activities and (2) the opportunity to participate in the agricultural education community through attendance and participation in related conferences and professional development opportunities. As Sidney noted, the program director and other educators with whom she interacted over the course of the program served as role models for future professorship in agricultural and Extension education. For Cameron, attending a regional STEM education conference helped give him a better idea of how the outreach education community operates as a profession. For Laurie, attending and presenting at a national agricultural education conference gave him access to a new academic setting and expanded his ideas for possible applications and publication venues for his research. Additionally, the flexibility and choice which the program director allowed the Graduate Extension Scholars to exercise over their module development activities allowed Hayden to leverage his activities in James County as a networking opportunity with local natural resource professionals. All of these instances provided access to role models within the community of agricultural education.

In addition to the interactive components of the program mentioned above, the program’s overall theoretical framework seemed to have a strong influence on participants’ professional identities in terms of their professed teaching styles. While most of the Graduate Extension
Scholars entered the program with a sense of themselves as educators, they also mostly saw education as direct instruction or “formal presentation.” Exposure to constructivist techniques and the program’s heavy emphasis on constructivist pedagogy seemed to influence participants’ conceptions of the “right way” to teach and adopt a more student-centered and experiential perspective. The reflective opportunities presented in the program, particularly seminar discussion, also seemed to assist participants in developing their teaching identities, as Cameron pointed out, “The seminar really has informed and guided the way that I want to teach and the goals that result from it.” The seminar group was described by all four Graduate Extension Scholars as a safe and welcoming community in which to explore new ideas about education.

**Limitations to professional identity development.** Though participants were mostly satisfied with the quantity and quality of situated learning opportunities made available to them through the program, they did mention that they enjoyed getting to know education professionals beyond the program director, researcher, and their direct community partners. Participants suggested that more frequent guest lectures would have been helpful in expanding the network of expert practitioners to whom they had exposure. Furthermore, Laurie suggested expanding the program’s community of practice to include more frequent involvement from the Graduate Extension Scholars’ research advisors and college leadership. His logic was that broader exposure to and acknowledgement of the program might increase advocacy for the program beyond the scope of its direct beneficiaries, thus potentially impacting the wider departmental and collegiate communities’ perspectives toward the benefits of outreach. In this suggestion, Laurie revealed evidence of a burgeoning boundary identity which sought to bring disparate communities of practice (the “educators” and the “scientists”) closer together. As Lave and Wenger (1991) note, newcomers can themselves contribute to the culture of the community of
practice within which they are participating. One aspect of professional identity development this study did not address was the potential to influence professional cultures beyond the identities of direct participants.

**Additional support for learning.** Two aspects of the program structure discussed by participants but not explicitly connected to either experiential learning or professional identity development were accountability and incentives for participation. The latter provided a “hook” to get participants involved, whereas the former sustained their engagement in the program’s activities, both essential perquisites to learning.

As Hayden pointed out, the financial support which the program provided for Graduate Extension Scholars was a determining factor for his participation. The travel expense and time sacrifice away from research and academics would have otherwise been difficult to justify. The assistantship supplement also made the program more attractive to his advisor, who was able to use it to hire additional undergraduate research technicians to support Hayden’s field work. For Sidney, Laurie, and Cameron, financial support to attend professional development opportunities like the regional STEM educator’s conference and national agricultural education conference was a key enabler for them to participate in these essential experiential learning and professional identity development activities. These were activities that the Graduate Extension Scholars would not have known about or been able to participate in, otherwise. The importance of removing financial barriers to participation in educational professional development activities and using financial incentives to mitigate time barriers to participation in outreach activities thus emerged as significant for the Graduate Extension Scholars.

Operating within an accountability structure, in this case a passing field study credit to achieved through active participation in the weekly seminar and timely completion of program
activities according to pre-determined deadlines, served as a motivator to participants. As Cameron and Hayden pointed out, they probably would not have learned as much if there had not been some element of accountability and pressure to “keep up” with program activities. This accountability, as Hayden and Sidney further pointed out, was augmented by the social structure of the program which enabled participants to compare their progress to that of their peers, inciting some sense of competitiveness or desire to remain “on pace” with their peer group. As Sidney pointed out, “Sometimes in class there will be a point by which we wanted to have had something done and [my community partners and I] are not quite there yet. So it helps in class to hear about it [from the other students].” Furthermore, as Cameron and Hayden pointed out, their community partners’ and the program director’s expectations for a deliverable product helped keep them motivated to work on his educational module in spite of competing demands from academic and research responsibilities. Accountability in the form of deadlines and social structures therefore helped sustain motivation for active learning and engagement among the Graduate Extension Scholars.

4.6. Summary of Findings

In summary, this case study of the Graduate Extension Scholars program found that participants identified as educators and saw outreach as a part of their professional identity both before and after participation in the program. Graduate Extension Scholars were motivated to participate out of a desire to fill gaps in their professional development around teaching and conducting broader impacts outreach activities, as well as out of a sense of social responsibility toward outreach. The opportunity was made attractive and justifiable to themselves and advisors due to the financial incentives and support provided by the program. A summary of findings
pertaining to participants’ professional identity and motivations for participation is provided in Figure 5, below.

![Table: Social Responsibility, Professional Development, Career Exploration]

**Figure 6:** Professional identity motivations for participation in the GES program

Upon concluding the program, Graduate Extension Scholars believed they were and appeared to be more skilled in lesson planning, lesson delivery, and writing of educational materials. In addition, participants also felt that the experience had augmented their general academic communication and scientific research skills. Furthermore, participants felt they had emerged from the program with a better sense of the culture and operations of both school-based and non-formal agricultural education as well as outreach education in general. A summary of these outcomes is provided in Figure 6, below.

![Table: Before and After]

**Figure 7:** Learning outcomes for GES participants.
Participant-identified learning outcomes were attributed to the social and experiential nature of the program, which allowed participants opportunities for observation, conceptualization, reflection, and application of their learning. Instruction supported participants’ experimentation with various teaching techniques, while “expert” feedback as well as peer discussion helped participants reinforce and refine their learning.

Graduate Extension Scholars exited the program with an affirmed sense of commitment and professional responsibility toward outreach. They also emerged with more positive attitudes toward teaching and collaboration in general, especially with K-12 educators. Participants’ respect for both school-based and non-formal agricultural educators was enhanced as a result of their interactions with these professionals. Furthermore, their inclination toward constructivist education was influenced by the program’s theoretical framework.

Though the Graduate Extension Scholars gained much from their experience, they did note the program’s limitations in fully developing their outreach and teaching skills. The abbreviated (one semester) timeline and lack of opportunity to practice with all aspects of curriculum delivery and program planning, particularly assessment of student learning and evaluation of program outcomes and delivery, were identified as areas of improvement for the program. However, participants admitted that developing expertise in education and outreach was a lifelong endeavor and felt that the program had equipped them with a strong basic foundation from which to build their knowledge. They felt their experience had been positive, overall, and emerged as strong advocates for the program’s continuation and replication in other settings. A final summary of program components contributing to learning is provided in Figure 7, below.
<table>
<thead>
<tr>
<th>Experiential Learning</th>
<th>Professional Identity</th>
<th>General Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Seminar</strong>: activated prior knowledge &amp; provided background</td>
<td>• <strong>Conferences &amp; Site Visits</strong>: Opportunity to interact with professionals</td>
<td></td>
</tr>
<tr>
<td>• <strong>Examples</strong>: Scaffolding</td>
<td>• <strong>Program director &amp; partners</strong>: Mentors &amp; role models for good teaching</td>
<td>• <strong>Stipend</strong>: Incentive for participation, made feasible</td>
</tr>
<tr>
<td>• <strong>Site Visits &amp; Interviews</strong>: Feedback &amp; Reflection</td>
<td></td>
<td>• <strong>Helpful staff</strong>: Technical support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <strong>Peer cohort</strong>: Accountability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <strong>Theoretical framework</strong>: Direction for learning</td>
</tr>
</tbody>
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**Figure 8**: Program Components Contributing to Participant Learning
5. CHAPTER FIVE: Conclusions & Recommendations

The purpose of this study was to examine the experiential learning and professional identity development of agricultural science participants in the Graduate Extension Scholars (GES) program, a K-12 outreach and professional development for CALS graduate students. As a reminder, this study addressed the following research questions:

1) How do participants situate their outreach experience within the contexts of their professional identities and future goals?

2) What perceptions and skill/knowledge gaps do graduate student participants have about outreach education before and after participating in the GES program?

3) By what learning processes do participants modify their perceptions and overcome skill/knowledge gaps about outreach education as they progress through the program?

4) What significance do participants assign to the various social, pedagogical, and experiential components of the program (i.e. program community, program activities, and program structure) with regard to their learning and identity development?

Preliminary results discussed in the previous chapter indicate that the pilot cohort of the Graduate Extension Scholars came into the program with a strong sense of public scholarship as exemplified by their commitment to the land-grant mission and values of Cooperative Extension. They were motivated to participate by a curiosity about the K-12 agricultural education system and a desire to enhance their teaching and outreach skills. Participation strengthened both their skills and knowledge of agricultural education as well as their commitment to outreach. Participants also modified their perceptions of the teaching process and profession as well as their conceptions of the appropriate purpose, methods, and target audience for outreach activities over the course of the program. Program structures enhanced the experiential learning process
and provided opportunities for legitimate peripheral participation in the agricultural education and K-12 STEM outreach communities. However, participants did provide feedback on the program structure which could enhance learning for future participants. The subsequent sections of this chapter discuss the ways in which these findings contribute to prior research. Implications for future research and program planning are also discussed.

5.1. Contributions to the Literature

5.1.1. On graduate students’ professional skill development. The learning outcomes identified in this study support existing literature on graduate student development through involvement in K-12 outreach. It has been shown by Crone et al. (2011) and Montano (2012) that with sufficient scaffolding in the form of training workshops or an accompanying credit-bearing class, graduate students’ teaching skills can be improved through involvement in K-12 outreach. In the case of the Graduate Extension Scholars, participants’ increased their knowledge of and skill with inquiry-based and other constructivist pedagogies, supporting prior research by Trautmann and Krasny (2006), as well as Thompson, Collins, Metzgar, Joeston, and Shepherd (2002). As a result of their experience, participants felt more confident in their ability to communicate science to students and other non-scientific audiences, a finding previously identified by Trautmann and Krasny (2006), and Montano (2012), as well as Laursen, Liston, Thiry, and Graf (2007). These findings support the potential of K-12 outreach to improve the teaching abilities of future faculty, as suggested by Tanner and Allen (2006).

The Graduate Extension Scholars also came to a better understanding of the challenges of teaching and how to manage them, such as making do with limited resources, modifying instruction for varying levels of student abilities and engagement, building students’ trust, and managing unanticipated questions from students. Understanding the challenges of teaching
increased their appreciation for educators. These findings support prior research by Trautmann and Krasny (2006), and Thompson et al. (2002) who found that participants in similar K-12 partnership programs had a better understanding of and confidence with managing the challenges of teaching. Further, this study supports research by Burrows et al. (2009), which revealed that participants in a K-12 partnerships program became more empathetic to the needs and issues facing K-12 educators, resulting in increased advocacy for K-12 partnership among participants.

It is significant to note that these previous studies were situated within the context of “core” academic subjects of science and mathematics, whereas the GES program was situated within the unique context of agricultural education, which is in most schools considered an “elective” subject. Though there are numerous cross-cutting mathematical and scientific concepts that can be brought to life through agriculture, agricultural education programs are often challenged to assert their relevance amid pressure for students to perform well on high-stakes tests in “core” subjects (Spindler & Greiman, 2013). Building a cadre of support at the university level for STEM integrated agricultural education could strengthen the position of these programs as an integral component in the effort to improve STEM education across the K-12 curriculum.

In addition to improved teaching skills and understanding of teaching, the Graduate Extension Scholars program revealed potential to benefit to participants’ development as researchers. Specifically, as Hayden mentioned, having to articulate research methods for high school students helped clarify his own understanding of and ability to discuss technical procedures. Furthermore, revisiting the inquiry process in an instructional context clarified his own understanding of the scientific method. These findings mirror those of Feldon, Peugh, Timmerman, Maher, Hurst, Strickland, Gilmore, and Stiegelmeyer (2011), who found that teaching improved the clarity and conciseness of graduate students’ research questions and
methodological discussions. More generally, Trautmann and Krasny (2006) found that graduate students gained a deeper appreciation for the practical applications of and public perspectives on their research, a finding also expressed by all four participants the Graduate Extension Scholars program. An additional previously unidentified finding around scientific skills that emerged for Sidney and Laurie was an improved understanding of and interest in social science research methodologies. This finding has implications for further investigation into the impact of interaction with social scientists on science graduate students’ inclination toward and ability to engage in cross-disciplinary collaboration.

One area of scientific communication not addressed in previous studies in which the Graduate Extension Scholars reported improvement included academic writing and presentation. Through preparing written summaries of their educational modules for publication on the program’s website and through presenting posters and oral presentations on their GES work for various conferences, the Graduate Extension Scholars felt they had improved their ability to articulate their ideas in writing and developed skills to write for a wider variety of audiences. Though Burrows et al. (2009) mention that participants in the STEP program similarly prepared written summaries, while Feldon et al. (2011) and Trautmann and Krasny (2006) noted that teaching improved graduate students’ scientific writing skills, an explicit connection between writing for an educational context and improved academic communication had not previously been made.

Based on the findings of this study, participation in the Graduate Extension Scholars program, like other K-12 outreach programs, presented an opportunity for participants to alleviate disconnects between training and practice in graduate education identified by Golde and Dore (2001). The Graduate Extension Scholars were exposed to several areas of professional
responsibility not normally addressed in their formal training, including pedagogical techniques, program management, and interdisciplinary collaboration (Austin, 2002). All four participants felt that they had gained a professional advantage over peers who had not had a similar experience, and felt more confident in their abilities to meet the diverse career demands of agricultural science faculty.

5.1.2. On graduate students’ professional identity development. Program entrance interviews revealed that GES participants were drawn to the program due to prior interest and commitment to outreach and education, implying that teaching and public scholarship were components of their professional identity prior to their participation in the program. This finding supports previous research by Crone et al. (2011) and Buck et al. (2006), who found that participation in outreach programs serves to affirm existing interests rather than revise graduate students’ self-concepts as educators. As Brownell and Tanner (2012) note, this affirmation might help participants to be more resistant to social pressures in academia that under-value teaching. In addition, as Buck et al. (2006) point out, participation the NSF GK-12 program helped female scientists expand burgeoning professional identities as educators. Participation in GK-12 also filled a void participants felt in traditional research-based assistantships by presenting and opportunity to provide a tangible social benefit. Findings from the Graduate Extension Scholars program extend this finding to include scientists of any gender. The theme of scientists’ social responsibility to “give back” by expanding public and/or practitioner knowledge was strong among the Graduate Extension Scholars from the onset of the program and was enhanced with participation. The most common complaint of Graduate Extension Scholars about their formal graduate training was a lack of opportunities to engage with the community in the ways they believed was essential to be an effective scientist and citizen. The GES program provided a safe
space where participants could address and nourish their sense of commitment to quality teaching and community engagement.

In addition to affirming their professional identity as educators and public scholars, this study found that GES participants’ pedagogical orientation, or teaching style, was also influenced by the program. Participants’ expressed teaching styles shifted toward more constructivist and experientialist perspectives over the course of their participation in the program. This result builds on prior research by Christodoulou et al. (2009) regarding curricular orientations of science graduate students participating in K-12 outreach. While Christodoulou et. al (2009) considered the influence of participants’ prior curricular orientations on their outreach teaching style, this study reveals that the theoretical framework guiding the training participants receive in preparation for outreach work may also influence their approach to outreach as well as their pedagogical perspective moving forward. Programs of this type can potentially help graduate students refine their personal philosophy toward education in addition to affirming their identity as educators.

Exit interviews also revealed that the Graduate Extension Scholars expressed an intent to continue or expand their involvement in outreach in their future professional lives. Notably, all four participants expressed an interest in continuing to work with K-12 students and teachers, a population which most of them had not previously considered as a target audience for broader impacts activities. This finding supports the work of Trautmann and Krasny (2006), who found that Cornell graduate students’ participation in the GK-12 program affirmed commitment to K-12 partnership. It also supports prior research by Montano (2012), who noted that positive experiences with “Portal to the Public” program positively influenced graduate students’ identity as science communicators and intention to continue outreach work in the future. As noted in
Chapter Two, Zhang et al. (2011), found that prior connections to the K-12 community were a strong predictor of faculty involvement in outreach programming through the NSF K-12 Math and Science Partnership, indicating that this commitment can be sustained in the long term. In addition, a longitudinal study by Beck, Morgan, Strand, and Woolsey (2006) showed that graduate students who volunteered in the K-12 setting as trainees sustained their involvement in outreach into their future careers. The intentions expressed by the Graduate Extension Scholars further support this connection between early-career involvement and sustained commitment to public engagement.

Though Montano (2012) and Laursen et al. (2007) found that participation in K-12 outreach influenced graduate students’ career trajectories away from research and toward more education-related roles, this study found that participation in the Graduate Extension Scholars program did not significantly affect graduate students career outlook. Rather, as Trautmann and Krasny (2006) also found, the Graduate Extension Scholars’ experience helped them refine their ideas about the exact setting in which they might work and the specific activities in which they might engage. For example, Cameron remained interested in academia but mentioned a desire to work for a smaller university where teaching would be more heavily emphasized. Hayden and Laurie remained committed to their respective career trajectories as agricultural science researchers and faculty, but expressed an interest in changing the methodology and expanding the audience of their requisite Extension activities.

5.1.3. On best practices for engaging graduate students in K-12 outreach. As Trautmann and Krasny (2006) note, prior research assessing the impact of K-12 partnership programs on scientists-in-training has been limited in its consideration of the mechanism by which observed impacts are achieved. Close examination of program activities and discussion with participants
about their learning processes revealed several important experiential learning processes supported by the program structure.

Participants’ feedback confirmed prior research demonstrating that the inclusion of a pedagogical training workshop or seminar helped them to be better prepared for their teaching experience and more likely to incorporate best practices for student-centered learning (Burrows et al., 2009; Collins, 2011; Crone et al., 2011; Montano, 2012). Furthermore, the Graduate Extension Scholars highlighted the importance of having resource professionals, in this case the program director and the researcher, to support participants with ongoing technical advice and provide feedback on performance. The program director also placed reasonable boundaries on the participants’ commitments, i.e. managing partner relationships and evaluation so participants could focus on curriculum development. These findings confirm prior research by Dolan et al. (2004) and Laursen et al. (2007), who identified such support staff as important components to successful outreach programming by scientists. The Graduate Extension Scholars’ teaching skill outcomes can tentatively be attributed to these support structures, as well as the fundamental aspect of having an opportunity to practice these skills. Participants positively received the module development “centerpiece” of the program and desired even more sustained engagement, including opportunities to evaluate and re-test their curricula. This finding supports prior research by Crone et al. (2011), who found the greatest learning gains when participants in an outreach training program were given iterative opportunities to plan, conducting, and evaluate an outreach project.

The collaborative nature of the Graduate Extension Scholars program, which allowed for the development of close relationships among the Graduate Extension Scholars, program staff, and participating educators, was a noted strength for participants. These relationships seemed to have
a strong influence on their learning about the nature of teaching, the structure and function of K-12 agricultural education, and attitudes toward future collaboration with educators. They also offered opportunities for group reflection and discussion, helping participants refine their ideas about outreach education. This finding supports the research of Laursen et al. (2007), who found that graduate students participating in K-12 outreach learned through “observation of skilled teachers and group discussions” (p. 60). It also supports Montano’s (2012) finding that positive relationships with educators positively influences graduate students’ outlook toward outreach.

One advantage of sustaining training throughout the experience in the form of a credit-bearing course of seminar not previously mentioned in prior research was the role of this accountability structure in keeping participants engaged in the program. The Graduate Extension Scholars doubted that they would have learned as much or made any significant progress on their module development projects if they were not required to meet weekly as a group throughout the duration of the program. In addition, though participants’ prior pedagogical orientation have been addressed in prior research by Christodoulou et al. (2009), the pedagogical orientation influencing the design of the outreach training program had not previously discussed. The apparent significance of the Graduate Extension Scholars seminar’s constructivist experiential theoretical framework on the subsequent ideas and teaching philosophies of participants must not be understated and deserves further investigation.

An additional consideration which emerged in this study of the Graduate Extension Scholars program was the importance of incentives to help participants justify participation. Prior studies discuss the challenges graduate students who wish to participate in K-12 outreach face in managing their time and justifying their outreach activities to their research advisors (Buck et al., 2006; Laursen et al., 2007; Thompson et al., 2002). Though time management certainly remained
a challenge for the Graduate Extension Scholars, the financial incentives provided to both participants and their research advisors may have helped to mitigate the pressure, as it added additional resources to the lab group to compensate for the scholar’s absence. Graduate Extension Scholars generally reported their advisors being supportive of their participation in the GES program. However, advisors’ blessing and the financial “buy out” seemed to have little effect on participants’ responsibility to maintain research productivity. However, because this study did not investigate advisors’ attitudes toward the program, it is not possible to determine whether the financial incentive had any meaningful impact on their supportiveness toward the Graduate Extension Scholars’ participation.

5.1.4. On Agricultural Education Reform in Higher Education. The findings of this study of the Graduate Extension Scholars program seem to support the suggestion of Tanner, Chatman, and Allen (2003) that professional hybrid “scientist-educators,” with experience in both professional communities, might be critical to promoting articulation between science teaching reform efforts in the K-12 and Higher Education communities. The Graduate Extension Scholars emerged from the program interested in developing a more student-centered teaching style and applying pedagogical best practices from the K-12 arena, such as inquiry-based learning, to their work as teaching assistants and adult Extension educators. More importantly, the Graduate Extension Scholars also showed a desire to spread what they had learned in the Graduate Extension Scholars program to their wider disciplinary communities. Several demonstrated advocacy behavior during or immediately after concluding the program by informally sharing their stories with colleagues and by presenting on their GES work at discipline-specific conferences.
The Graduate Extension Scholars’ emerging identities as “outreach advocates” bode well for their professional trajectories as “boundary workers” between the K-12 and higher education communities, a key to both K-12 and high education science teaching reform according to Bouwma-Gearhart et al. (2014), Tanner et al. (2003), and Dolan et al. (2004). The Graduate Extension Scholars’ burgeoning identities as constructivist educators also is promising for the improvement of undergraduate agricultural education called for by the National Academy of Sciences (2009), and Blickenstaff et al. (2015). Their expressed interest in continuing with K-12 partnership also supports the integration of scientific process skill and real-world applications into to school-based science and agricultural education, as advocated in the Next Generation Science Standards and supported by the American Association for Agricultural Education and others (Achieve Incorporated, 2013; Doerfert, 2011; Myers & Washburn, 2008; Spindler & Greiman, 2013). Overall, the program shows promise for strengthening agricultural scientists’ skills and professional identities around teaching and public scholarship, as recommended by Blickenstaff et al. (2015) and Bagdonis and Dodd (2010).

5.2. Recommendations

5.2.1. For future program design. Based on the results described above, the Graduate Extension Scholars program showed promise in the following areas: (1) helping graduate students develop confidence in their teaching and outreach project planning skills, (2) exposing graduate students to innovative approaches to teaching & outreach activities, (3) helping graduate students overcome professional identify barriers to participating in teaching and outreach activities, and (4) increasing graduate students’ intention to conduct outreach, especially in the K-12 setting.
However, participants’ feedback and researchers’ observations revealed that learning was limited by the short duration of the program. Additional practice with constructivist pedagogical methods, program planning, and evaluation; as well as more prolonged exposure to the formal agricultural education and Cooperative Extension systems would be needed for participants to develop more extensive expertise. A program timeline of at least one academic year, expanded from one semester is recommended to improve coverage of relevant information and ensure sufficient time for iterative program design and implementation. In addition, as Crone et al. (2011) recommend, participants should have an opportunity to practice with the full range of educational module planning activities, including assessment of student learning and evaluation of the outreach effort, including an opportunity to revise and re-pilot their module afterward.

Strengths of the Graduate Extension Scholars program which should be retained in future iterations and considered for the development of similar programs included (1) the opportunity to observe and interact with agricultural educators in a variety of settings, (2) the opportunity to investigate outreach pedagogy from both a theoretical and experiential perspective, and (3) the opportunity to reflect, discuss, and refine ideas with peers. Program planners should consider the training seminar or workshop as more not only an opportunity to provide participants with prerequisite knowledge about teaching and learning, but also as an important social component of the program. It is therefore recommended that training be sustained throughout the duration of outreach involvement to maximize the benefits of group reflection and accountability, rather than simply providing a preparatory “crash course” before participants commence teaching, as is the case in some programs.

The Graduate Extension Scholars also greatly appreciated the guidance and feedback they received from the program director, researcher, and their partner educators on lesson plans and
teaching performance. It is recommended that this element be retained and, if possible, expanded, as participants appreciated receiving feedback from multiple sources. If time and resource constraints prevent program staff from attending every graduate student’s curriculum deliver session, which will likely be the case for most programs, partnering educators should be explicitly informed of expectations for providing feedback to graduate student presenters. Assessment rubrics might help them provide more detailed feedback in accordance with the program’s learning objectives.

In regard to program objectives, careful consideration should also be given to the program’s theoretical orientation and the desired pedagogical approach. One of the strengths participants reported for the Graduate Extension Scholars program was that the format of training activities was well-aligned with the program leadership’s expectations for how they should be teaching in the K-12 classroom. If outreach programs hope to promote student-centered teaching, they must model this for participants in their approach to teaching pedagogical methods. As Collins (2011) notes, community partners and mentors should be carefully selected to ensure that they are effective role-models for student-centered teaching.

Lastly, when considering that K-12 outreach professional development programs are competing with multiple demands on graduate students’ time and energy, steps should be taken to incentivize participation and mitigate the sacrifices graduate students must make to participate. Financial incentives worked well for the Graduate Extension Scholars program by helping participants justify participation to themselves and possibly their research advisors. They also eased the financial burden of travel to partner sites and helped remove financial barriers to their participation in education-related conferences. The opportunity to present on their work could be more heavily emphasized as a possible incentive, as well as the potential to produce a
publishable 4-H curriculum which might be disseminated in Extension or youth-development-related journals. Further conversation with the Graduate Extension Scholars’ research advisors about the program’s time commitments and rewards might also aid participants in developing flexible research or outreach timelines to further mitigate the challenge of balancing research and outreach responsibilities.

5.2.2. For graduate student professional development. The preliminary successes of the Graduate Extension Scholars program show that by fostering partnerships between departments of agricultural education and communication and departments of the lab and field-based agricultural sciences, Colleges of Agriculture can expand their graduate training programs to more fully cover the range of relevant skills that are in high-demand for agricultural scientists (Doerfert, 2011; National Academy of Sciences, 2009). As Trautmann and Krasny (2006) note, graduate students participating in K-12 partnership programs receive more mentoring and feedback on their teaching than students participating in traditional graduate assistantships, resulting in greater gains in their teaching abilities. This finding was demonstrated in the Graduate Extension Scholars program though the participants’ express appreciation for the extensive training and feedback they received on their curriculum writing and teaching, something they pointed out had not been present in their prior TA experiences.

If College of Agriculture seek to develop high-quality undergraduate educators as well as researchers, they might consider adopting some of the best-practices listed above for K-12 outreach training into their teaching assistantship programs. In addition, expanding the availability of alternative assistantship programs like the GK-12 program, which is very similar to the Graduate Extension Scholars program, might help address the dearth of opportunities for agricultural science graduate students to engage in public scholarship identified by Bagdonis and
Dodd (2010). College of Agriculture should also consider that not all agricultural science
graduate students go on to careers in academia. More outreach and Extension-related
assistantship opportunities might better prepare graduate students for future responsibilities as
Extension agents and specialists as well as industry representatives.

It is necessary to identify funding streams for alternative graduate training programs. Though
it is very similar to the GK-12 model, the Graduate Extension Scholars program provides only an
add-on stipend to graduate students’ existing funding. The GK-12 program was an alternative
assistantship program through which participants were fully funded. Support for the Graduate
Extension Scholars program comes through a departmental grant program and is not guaranteed
on an annual basis. In contrast, GK-12 projects were sustained by a multi-year NSF grant.
However, the disadvantage of a grant-based model is that support is subject to change based on
the availability of funds. In a prime example of this instability, the NSF actually discontinued the
GK-12 program in 2012 (Mervis, 2011). Additional research into the feasibility of replicating
and sustaining the GK-12 model in the setting of agricultural education would be helpful.
Existing funding streams which support agricultural education and extension activities, such as
the USDA, could potentially fill the funding gap if sufficient demand is identified through
further research. Alternately, departments could collaborate to share the burden of funding
alternative graduate assistantships if they are seen as valuable and mutually beneficial to the
collaborating parties.

5.2.3. For further research. The results Graduate Extension Scholars program are
promising, but additional research is needed to support the initial results identified in this case
study. A particular limitation of this study was that outcomes were identified through participant
self-report supplemented by occasional observation of the participants’ teaching by the
researcher. A more in-depth assessment of participants’ teaching skill development might involve systematic observation according to a performance rubric before and after participation in the program as well as pre-post knowledge assessment. Furthermore, though participants expressed desire to persist with more student-centered teaching and claimed they would continue or expand their involvement in outreach, longitudinal research is needed to determine whether these intentions, orientations, and most importantly actions persist beyond graduate study and into the Graduate Extension Scholars’ professional lives. Of particular interest to this researcher is whether participants succeed in applying their learning about best practices in the K-12 outreach setting to their university teaching and adult Extension activities.

There were several aspects of the Graduate Extension Scholars program that this study did not investigate due to limitations in scope. Based on anecdotal mention of advisors’ and lab groups’ supportiveness of their GES activities, additional research into the role of the Graduate Extension Scholars’ research advisors in their learning would be helpful. Particularly, advisors’ personal attributes, motives and incentives for supporting their graduate students’ outreach activities would shed light on ways this support could be further encouraged. Likewise, the role of the partner educators cannot be understated and deserves more in-depth investigation. Some information about community partners’ motivations for participation and satisfaction with the program was collected for evaluative purposes and will be reported in a forthcoming paper by Scherer, Wilk, Wiley, Archibald, and Spindler (2016). However, more in-depth investigation of community partners’ roles in participants’ learning and the ways in which they were supported in those roles by the program leadership would be informative.

Additionally, though Kolb’s (1984) experiential learning cycle and Lave and Wenger’s (1991) situated learning theory were selected as the theoretical framework through which
participants’ learning and professional identity development was examined, examination through different frameworks as well as more in-depth investigation according to these existing frameworks would provide ample questions for further investigation. Particularly, Bandura’s (1997) social learning theory and Wenger’s (1998) *Communities of Practice* might shed additional light into the ways in which participants learned from the social structures of the program. More in-depth exploration of the Graduate Extension Scholars’ learning styles according to Kolb’s (1976) *Learning Style Inventory* or another learning style assessment might provide more detail into the particular program activities that are more effective for different types of learners, enabling program leadership to tailor their approach for different learners. Furthermore, pre- and post-assessment of participants curricular orientations using Schubert’s (1996) model or a similar framework might provide a more detailed picture of participants’ changing teaching styles.

For continued evaluation of future iterations of the Graduate Extension Scholars program, a suggested approach to build upon the findings identified in this case study should keep in mind functionality. First, some assessment of participants’ initial motivations for applying for the program, teaching skills, teaching style, knowledge, and professional identity around teaching and outreach is recommended. This might be accomplished through an application essay and submission of a sample lesson plan and teaching demonstration. These materials could then be used as comparison against various iterations of lesson planning and delivery produced throughout the program, ideally demonstrating progress when measured against the final product. A mid-point reflection essay might capture emerging learning processes, whereas an exit interview or reflection essay would help summarize participant-perceived outcomes as well as participants’ suggestions for improvement for future iterations of the program. It is also
recommended that the program leadership attempt to follow up with Graduate Extension Scholars a few semesters after they have completed the program to see if they are applying anything they have learned to their other teaching responsibilities. A follow up is also recommended after participants have completed their degree and commenced their professional careers to assess whether they are continuing their involvement in outreach. This proposed scheme is of course one of many possible options for continued program evaluation and is based solely on the researcher’s opinion on what might be feasible and useful in the immediate future.

5.3. Conclusions

In conclusion, this case study indicates that experiential learning and legitimate peripheral participation in the agricultural education community resulted in a more nuanced understanding of the activities, values, and standards of practice of public scholarship in the area of K-12 outreach for participants in the Graduate Extension Scholars program. Though participants already identified as educators and/or public scholars to a certain extent before entering the program, there was evidence that their experience affirmed this identity and led to some modifications in the way they intended to approach their work (Buck et al., 2006; Crone et al., 2011). In particular, this study found that participants’ commitment to outreach, particularly in the K-12 arena, was strengthened, supporting previous research by Montano (2012) and others.

Participants’ pedagogical orientations also shifted toward the more constructivist and experiential approaches promoted in 4-H and school-based agricultural education programs. This finding supports prior research indicating the potential for K-12 outreach to improve graduate students’ teaching (Laursen et al., 2007; Thompson et al., 2002). The Graduate Extension Scholars were exposed to several areas of professional responsibility not normally addressed in their formal training, including teaching techniques, program management skills, and the
challenges of interdisciplinary and inter-agency collaboration (Bagdonis & Dodd, 2010). The Graduate Extension Scholars reported knowledge gains in all of these areas, indicating that participation the Graduate Extension Scholars program presented an opportunity to alleviate disconnects between training and practice in graduate education identified by Golde and Dore (2001), Austin (2002), and Bouwma-Gearhart (2012), potentially leading to a more robust professional identity around public scholarship (Bagdonis & Dodd, 2010).

This case study adds to a growing body of evidence for the potential of involvement in K-12 outreach to improve science graduate students’ teaching skills and sense of professional commitment to outreach, expanding it to the field of agricultural science. Additional longitudinal research is needed to assess whether participants retain the skill and professional identity outcomes identified in this case study. In addition, this case study opens new questions about graduate students’ teaching and learning styles, the role of prior experience and their advisors on their professional trajectories, and the relationships between graduate students, their advisors, and their community partners in the context of outreach programming. Furthermore, this case study raises questions about the potential for graduate students who are involved in K-12 outreach to play a role in cultural change within the agricultural sciences regarding the professional value of teaching and outreach and the provision of training in these areas for graduate students. Additional long-term investigation of the Graduate Extension Scholars program and other comparable programs is recommended to identify the long-term benefits of K-12 outreach for improving agricultural education in accordance with the goals of the National Academy of Sciences (2009) and for enhancing agricultural science faculty’s capacities for public scholarship as recommended by Bagdonis and Dodd (2010).
REFERENCES


Bouwma-Gearhart, J. (2012). Research University STEM Faculty Members’ Motivation to Engage in Teaching Professional Development: Building the Choir Through an Appeal to


National 4-H Council. (2014a). About 4-H. Retrieved from [http://www.4-h.org/about/](http://www.4-h.org/about/)


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APPENDICES

Appendix A. Typical Outreach Formats and Examples

<table>
<thead>
<tr>
<th>“Scientist in the classroom”</th>
<th>Scientists partner with teachers to deliver demonstrations or to co-develop and deliver curricula</th>
<th>GK-12 Math &amp; Science Partnership Project SEARCH</th>
<th><a href="http://www.gk12.org/">http://www.gk12.org/</a> <a href="http://www.nsf.gov/ehr/MSP/">http://www.nsf.gov/ehr/MSP/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Initiatives</td>
<td>Connect students and teachers to scientific tools and software</td>
<td>Biology Workbench (PCR) Chickscope (MRI) Bugscope (SEM) Ilab (various)</td>
<td><a href="http://workbench.sdsc.edu/">http://workbench.sdsc.edu/</a> <a href="http://chickscope.beckman.uiuc.edu">http://chickscope.beckman.uiuc.edu</a> <a href="http://bugscope.beckman.uiuc.edu/">http://bugscope.beckman.uiuc.edu/</a> <a href="http://www.ilabcentral.org/">http://www.ilabcentral.org/</a></td>
</tr>
<tr>
<td>Field Trips</td>
<td>Teachers bring students to local science centers and/or labs</td>
<td>Virginia Museum of Natural History open laboratories</td>
<td><a href="http://www.vmhn.net">www.vmhn.net</a></td>
</tr>
<tr>
<td>Citizen Science</td>
<td>Students &amp; teachers contribute data to ongoing projects</td>
<td>PREP (genetics) GLOBE (atmospheric)</td>
<td><a href="http://www.prep.biochem.vt.edu/">http://www.prep.biochem.vt.edu/</a> <a href="https://www.globe.gov/">https://www.globe.gov/</a></td>
</tr>
<tr>
<td>Summer Programs</td>
<td>Scientists or science centers host students for research internships or summer camps.</td>
<td>VA Governor’s Schools Summer Science Academies</td>
<td><a href="http://www.doe.virginia.gov/instruction/governors_school_programs/summer_residential/">http://www.doe.virginia.gov/instruction/governors_school_programs/summer_residential/</a> <a href="http://summersession.duke.edu/high-school-students/duke-summer-academy">http://summersession.duke.edu/high-school-students/duke-summer-academy</a></td>
</tr>
<tr>
<td>“Saturday Science”</td>
<td>Scientists host single day educational activities and demonstrations on-campus</td>
<td>BOAST Program Hokie Bug Fest</td>
<td><a href="http://www.life.illinois.edu/boast1/index.htm">http://www.life.illinois.edu/boast1/index.htm</a> <a href="http://hokiebugfest.ext.vt.edu/">http://hokiebugfest.ext.vt.edu/</a></td>
</tr>
</tbody>
</table>

*It should be noted that a number of well-established programs combine one or more of these outreach formats. For example, the HERP project out of the University of North Carolina - Greensboro offers summer camps, internships, citizen science projects, curricula for teachers, and a variety of other public engagement efforts not mentioned, above, such as a participatory storytelling series – the “nature chronicles.” http://theherpproject.uncg.edu/
Appendix B. Outreach Benefits to Scientists and Educators

**Teachers**
- Increased content knowledge
- Improved research skills
- Scientific tools & resources

**Scientists**
- Understanding of education
- Awareness of career options
- Personal satisfaction from professional contributions
- Ability to communicate to non-scientific audiences
- Enhanced identity as scientists

**Both**
- Enhanced understanding of inquiry
- Insights into teaching & learning

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**Figure 9:** Benefits from scientist-teacher collaboration. Adapted from “Scientists' and Teachers' Perspectives About Collaboration” by B. H. Munson, M.A. Martz, & S. Shimek, 2013, *Journal of College Science Teaching, 43*(2). P. 31. Copyright 2013 by the Journal of College Science Teaching.
Appendix C. Graduate Extension Scholars 2014-2015 Budget

Graduate extension scholars pilot program: preparing the next generation of agricultural scientists to engage in quality outreach
2014 Community Viability Mini-Grant Proposal
Submitted by: Hannah H. Scherer (PI), Research Assistant Professor, ALCE
Kathleen Jamison (co-PI), Extension Specialist, 4-H Youth Development

Budget: Total requested funds = $22,000

1. Graduate student support. The primary need for graduate students will be time to work on their outreach project; salary support to provide this time will come from the grant and matching funds.
   Requested funds: $3,500/student x 4 students = $14,000
   • To be used for summer salary and/or research support
   Matching funds: $5,000/student x 4 students = $20,000
   • Molecular Plant Sciences (1 student)
     o Source: unrestricted funds from Virginia Tech IGEP grant
   • Horticulture (1 student)
     o Source: Horticulture Departmental GTA (Fund # 120290)
   • Crop & Soil Environmental Sciences (2 students)
     o Source: DOE Bioenergy and USDA SARE research funds awarded to John Fike

2. Educational outreach program support.
   Requested funds: $1,500/team x 4 teams = $6,000
   • $250 honoraria for each partner agriculture teacher (4) = $1,000
   • $250 program support for 4-H agents (4) = $1,000
   • $500/team for travel related to planning, delivery, and dissemination = $2,000
   • $500/team for supplies and printing of educational program materials = $2,000

3. Program evaluation. Evaluation of this pilot program is critical in order to seek external funding and garner institutional support for its continuation. These funds will be used to hire a graduate student in ALCE for Summer 2015. This student will be responsible for collecting, transcribing, analyzing, and disseminating evaluation data.
   Requested funds: $1,500
   Matching funds: $1,500
   • Source: ACLE Departmental Summer Research Scholarship (2015)

4. Dissemination. Conference registration and travel for PI to share results of the evaluation with a national audience.
   Requested funds: $500
   Matching funds: $500
   • PI Academic Year salary (time to work on project)
## Appendix D. Graduate Extension Scholars Seminar 2014-2015 Seminar Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Topics</th>
<th>Checkpoints/ Items due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 23</td>
<td>Overview, updates, questions, concerns</td>
<td></td>
</tr>
<tr>
<td>Jan 30</td>
<td>Developing learning objectives/ essential questions</td>
<td>Initial team meeting completed</td>
</tr>
<tr>
<td>Feb 6</td>
<td>Engaging with stakeholders</td>
<td></td>
</tr>
<tr>
<td>Feb 13</td>
<td>4-H and school-based agricultural education; observations and bigger context discussion</td>
<td>Initial site visits completed (10 pts)</td>
</tr>
<tr>
<td>Feb 20</td>
<td>Evaluation <em>(Guest Faculty Lecture)</em></td>
<td></td>
</tr>
<tr>
<td>Feb 27</td>
<td>Peer critique of outlines</td>
<td>Outline of module due (10 pts)</td>
</tr>
<tr>
<td>Mar 6</td>
<td>Science teaching methods <em>(Hayden)</em></td>
<td></td>
</tr>
<tr>
<td>Mar 13</td>
<td><strong>No Class: Spring Break</strong></td>
<td></td>
</tr>
<tr>
<td>Mar 20</td>
<td>Communicating science; reduction of complex ideas <em>(Laurie)</em></td>
<td>Activity overviews and draft materials list due (10 pts)</td>
</tr>
<tr>
<td>Mar 27</td>
<td>Delivery of lessons/ engagement strategies <em>(Sidney)</em></td>
<td></td>
</tr>
<tr>
<td>Apr 3</td>
<td>Peer critique of module draft</td>
<td>Complete first draft of module due for review (20 pts)</td>
</tr>
<tr>
<td>Apr 10</td>
<td>Classroom management strategies for formal and non-formal agricultural education <em>(Cameron)</em></td>
<td></td>
</tr>
<tr>
<td>Apr 17</td>
<td>Educational project development/ conceptual frameworks for bigger projects <em>(Guest Faculty Lecture)</em></td>
<td></td>
</tr>
<tr>
<td>Apr 24</td>
<td>Outreach/ broader impacts in federal grants <em>(Guest Faculty Lecture)</em></td>
<td></td>
</tr>
<tr>
<td>May 1</td>
<td>Debrief of pilots and planning for final revisions</td>
<td>Pilots must be completed (10 pts)</td>
</tr>
<tr>
<td>May 8</td>
<td>SWVA STEM Summit- Inn @VT <em>(Finals Begin)</em></td>
<td>Poster presentation?</td>
</tr>
<tr>
<td>May 13</td>
<td>End of Finals</td>
<td>Revised draft of module due for web publishing (20 pts)</td>
</tr>
</tbody>
</table>
Appendix E. IRB Approval

Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0059
e-mail irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE: January 26, 2015
TO: Matthew Kenneth Spindler, Ayla Arsel Wilk
FROM: Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)

PROTOCOL TITLE: Crossing boundaries: learning and professional identity in an outreach-and-education training program for pre-professional agricultural scientists

IRB NUMBER: 15-009

Effective January 23, 2015, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As: Expedited, under 45 CFR 46.110 category(ies) 5,6,7
Protocol Approval Date: January 23, 2015
Protocol Expiration Date: January 22, 2016
Continuing Review Due Date: January 8, 2016

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.
Appendix F. Instrumentation

Interview and participant reflection guides used in this study are provided below. Main interview questions are in plain text and researcher probes/reminders are italicized.

1. **Entrance Interview:**

1) To begin, why don’t you tell me a little bit about yourself? *(listen/probe for prior experience and/or interest in education and outreach)*

   a. What are you studying in graduate school?

   b. What interested you in that topic?

2) How did you get involved with the Graduate Extension Scholars Program? *(listen/probe for prior experience and/or interest in education and outreach, influence of faculty advisor, career goals)*

   a. What factors influenced you to participate in the program? (advisor, prior interest, etc.)

3) How would you describe the program, based on what you know of it so far? *(listen/probe for understanding of program goals, objectives, relation to & perceptions of the field of education)*

4) What do you think it means to “be” an educator? *(listen/probe for values & identity around teaching/outreach education)*

5) What initial feelings to you have about the program? *(listen/probe for ideas/feelings about outreach, education, public speaking, working with youth, etc.)*

   a. What feelings do the idea of public speaking evoke for you?

   b. Working with youth?

   c. Anything else you’re excited about?
d. Nervous or hesitant about?

6) What do you believe you will gain from the program? (listen/probe for relation of program to professional goals, career interests)

7) How do you see your participation in the GES program fitting in with your career goals?

8) What aspect(s) of the program do you think you’ll find most challenging? (listen/probe for ideas/feelings about outreach, education, public speaking, working with youth, etc.)

9) Who do you anticipate will be able to assist you with these challenging aspects?
   (listen/probe for role of program director, faculty advisor, 4-H agents, agriculture teachers, & fellow scholars)

2. Mid-Program Interview:

1) Tell me about your impressions of the Graduate Extension Scholars program so far:
   (make note of comments about peer/partner relationships, challenges, benefits, curriculum planning, or learning to follow up on, later)
   
   b. How is it comparing to your initial expectations?

1) What are the goals of the program as you see them, now?

   a. For the program director
   
   b. For your teacher
   
   c. For your 4H agent
   
   d. For yourself

2) Describe your curriculum idea for me as you conceive of it, now.

   a. How did it get to this stage? What changes has it undergone? What initiated those changes?
   
   b. What do you see as your partners’ goals for your project? Hannah’s? Yours?
c. How have you changed your project to relate to the goals of your partners?

d. In response to what you’ve learned in seminar?

e. What is your impression, so far, of the curriculum planning process?

f. What do you feel you’ve learned from it? (if mentioned)

3) Tell me about your experience practicing/delivering your curriculum: [if they’ve done it]:

   a. What was the experience of delivering your lesson, like?

   b. What was most challenging and/or

   c. Rewarding about the experience?

   d. What were your main learning “take-aways” from the experience?

   e. How does it compare to your prior teaching experience?

4) Describe for me everyone who is involved in your curriculum project to this point as partners, participants, or stakeholders (make note of advisor involvement if mentioned).

   a. What is everyone’s role in the project?

   b. What are those relationships like for you?

   c. What is communication like among different parties?

   d. What do you feel each of the people you’ve mentioned bring the table?

      (What have you learned from these people? What do they add?)

5) Describe your sources of support for the project, both social and physical/financial:

   (make note of peer support, etc. for later)

   a. Role of Program director & researcher

   b. How does the program play into your funding package and research responsibilities?

   c. What is your advisor’s role in the project?
d. Who else have you been talking to/are planning to talk to?

e. Any other resources you’ve found helpful?

6) Describe your relationship with your fellow Graduate Extension Scholars:

   a. How do you support each other? Challenge each other?
   
   b. What is the significance of this peer connection for you?
   
   c. What is the role of sharing different perspectives in your learning? (if mentioned)

7) What is your impression, so far, of the weekly seminar?

(pay attention to what is mentioned, first)

   a. What stood out as significant? Helpful?
   
   b. Is there anything you’ve struggled to connect to your work?
   
   c. Anything you would change?
   
   d. Have you used anything you’ve learned? How?
   
   e. How would you describe the energy of the seminar sessions?
   
   f. How do you feel when you leave seminar?

8) What aspect of the program so far has particularly interested you or held your attention?

(listen/probe for new ideas or interests; discussion of education issues, each other’s science)

9) What aspects have you found most challenging? (listen/probe for translating science to public, communication with partners, finding time to work, etc.)

   a. If time arises as an issue – discuss how they prioritize time
   
   b. If expectations arise – ask how they feel about the expectations Hannah has set
   
   c. Describe the process by which you’ve worked through this challenge.
d. What aspect(s) of the program have been helpful in navigating challenges?

e. What has kept you motivated to continue through challenges?

10) What have been some of the outcomes of the program for you, so far?

(listen probe for learning, social/professional benefits, professional identity, etc.)

  a. As a scientist?
  
  b. As an educator?
  
  c. As a professional?

11) What do you see as the main value of the program for yourself? Your partners? The College?

12) How has this program translated into other aspects of your life? (professional, student, etc.) (listen/probe for evidence that scholars are incorporating concepts about education into presentations/teaching assistantship or other activities related to their research)

13) Do you have any general feedback about the program so far?

3. Exit Interview:

1) What were your overall impressions of the Graduate Extension Scholars program?

  a. Was it what you expected?
  
  b. Comparison to prior teaching/learning experience?
  
  c. Relationship to research: insights/influence? Helpful? Hindrance (time)?

2) Describe your experience delivering your final curriculum.

  a. What was challenging? Enjoyable?
  
  b. What informed your approach?
    
    i. Prior experience? Hannah? Teacher/4H agent?
  
    c. How did your approach change over multiple sessions?
d. How might you change your approach in the future, based on your experience?

3) Describe your experience of preparing your final write up:
   a. What was challenging/fun?
   b. What did you learn from it?
   c. Impact on project?

4) Describe your experience of presenting at NACTA/VAAE:
   b. What motivated you to present there?
   c. What was challenging/fun about it?
   d. What did you learn?
   e. Impact on project?

5) What were some of the main benefits of the program to you?
   e. Relationship to professional goals?

6) What, ultimately, were some of the main challenges you faced during the program?
   a. How did you ultimately work through them?

7) Where/how did you ultimately find support throughout the program?
   a. In what way(s) were these individuals and/or support structures helpful?
      (emotional vs. technical)
   b. Were there any sources you thought would be more supportive but weren’t?
   c. Any who were unexpectedly supportive/helpful?
   d. How might you have coped w/o these support structures?

8) How would you describe your relationship(s) with the other people involved now that
   you’ve completed the program together (incl. peers, 4-H agent, teacher, program director,
   researcher, advisors, and any others involved)?
a. What, ultimately, were their roles?

b. What did you learn from them?

c. Do you think you’ll stay in touch?

9) How do you think about outreach, now that you’ve completed the program?

a. With youth?

b. With adults/farmers?

c. Purpose?

d. Reach – breadth or depth?

e. Commitment/interest in it?

f. Incorporation into future research/grant-writing that wouldn’t have done before?

g. Reasons for continuing involvement?

10) How do you think about the process of teaching, now?

a. New insights into methods/technical aspects?

b. Your level of personal interest in/commitment to it?

c. Personal teaching style? Role of GES experience in forming (compare to prior experience.)?

11) How do you think about education as a field?

a. Perceptions of teachers?

b. Perceptions of informal education institutions (FFA/4H)?

c. What does being an educator mean to you?

d. What place does that in your life/the way you see yourself?

12) What main ideas from your overall experience have “stuck” with you?

a. About teaching/learning?
b. Working with communities/schools?

c. About your personal interests/teaching style?

d. About time management?

e. Why do you think they’re relevant?

13) What practices (if any) would you like to incorporate in your future work?

   e. Teaching methods (college)?

   f. Language/terminology?

   g. Approaches to working w/people?

   h. General lessons learned?

4. Participant Self-Reflection Guide:

The following questions were posited to participants prior to/at the conclusion of each site visit (either planning or curriculum delivery) to determine initial impressions, changes in thinking, and/or overall impressions of the experience.

Pre-visit:

1) What is going through your mind as you prepare for the visit?

2) What feelings/emotions are you experiencing in preparation for the visit?

3) What questions do you have for your partnering teacher and/or 4-H agent?

4) What are you curious to see or know more about?

5) What curriculum ideas would you like to bring up in planning or try w/students?

Post-visit:

1) What were your general impressions of the visit?

2) What feelings or emotions are you left with?
3) What “stood out” to you from the visit? Describe any topics of conversation or things you saw that made an impression.

4) What new ideas did you generate about your curriculum or about teaching in general?

5) What (if any) questions are you left with at the conclusion of the meeting?
## Appendix G. Codes & Categories from Data Analysis

<table>
<thead>
<tr>
<th>Category</th>
<th>Codes</th>
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</table>
| **Context - Experience**          | Partner site  
Prior teaching experience                                           |
| **Context - Motivations**         | Desire to share passion for science  
Grounding/Connection to research applications  
Professional Expectation  
Public Benefit  
Self-improvement/career preparation  
Financial support  
Personal enjoyment |
| **Identity - Career Interests**   | Initial Career Interests  
Affirmed/Expanded Career Interests | |
| **Identity - Intellectual Interests** | Primary Research Interests (Initial)  
Interest in education (Initial)  
New questions/interests in education  
New research questions/interests |
| **Identity – Outreach**           | Initial Sense of Value/Commitment to Outreach  
Expanded sense of value/commitment to outreach |
| **Identity - Self-concept**       | Initial: Embattled Educator  
Initial: Science Advocate  
Final: Education Advocate  
Final: Empowered/Affirmed Educator |
| **Identity - Teaching Style**     | Initial Teaching Style  
Final (changed) Teaching Style |
| **Knowledge Gaps (overcome or addressed)** | Educational Theory  
Environment of K-12  
How to communicate in education (presentation/curriculum writing)?  
How to communicate science to non-scientific audience?  
Nature of teaching (challenges/realities)  
Pedagogical techniques  
Project planning  
Roles of Extension & Agricultural Education  
Teaching process (how to)  
Collaboration (process)  
Educational research (process) |
| **Knowledge Gaps (lingering – evidence of)** | Teaching process  
Pedagogical techniques  
Roles of Extension & Agricultural Education  
Time management |
| **Kolb: Active Experimentation (Extension)** | Practice/experimentation (w/curriculum delivery on site/in seminar)  
Application (of concepts learned in seminar to module/teaching)  
Discourse (use of educational concepts in seminar) |
| **Kolb: Abstract Conceptualization (Comprehension)** | Instruction (in seminar)  
Models/templates  
Discourse (working through ideas w/peers in seminar)  
Feedback (instruction outside seminar)  
Research (independently reading/consulting experts outside seminar) |
| **Kolb: Concrete Experience (Apprehension)** | Prior teaching experience  
Interaction (with educators & education experts)  
Observation (of educators & education experts)  
Practice/experimentation (w/curriculum delivery on site/in seminar) |
| Kolb: Reflective Observation (Intention) | Observation (of educators & education experts)  
| Reflection (on experience/instruction)  
| Feedback (reflection on performance) |
| Lave/Wenger: Legitimization | Affirmation (in ability/value of teaching/outreach, from experts) |
| Lave/Wenger: Participation | Interaction (with educators & education experts)  
| Observation (of educators & education experts)  
| Practice/experimentation (w/curriculum delivery on site/in seminar) |
| Lave/Wenger: Reification | Affirmation (in ability/value of teaching/outreach, from experts)  
| Instruction (in seminar)  
| Reflection (on experience/instruction)  
| Models/templates  
| Discourse (use of educational concepts in seminar) |
| Perceptions - K-12 Education<sup>1</sup> | (Initial) – science inquiry as a separate endeavor from teaching  
| (Initial) - teachers as "non-experts" (in science)  
| (Initial) - teaching as formal presentation/direct instruction  
| (Initial) - there's a "one right way" to teach  
| (Change) - educators as respected experts (in science and human behavior)  
| (Change) - expanded sense of possibilities for inquiry in teaching  
| (Change) - more positive outlook on teaching  
| (Change) – expanded pedagogical options, multiple “right ways” to teach  
| (Change) – more positive outlook toward collaboration (w/K-12 & in general) |
| Perceptions - Outreach<sup>18</sup> | Outreach as a complex, community-based political/social system  
| Outreach is publicly valued  
| Purpose of outreach = diffusion of innovation  
| Purpose of outreach = encouraging critical thought  
| Purpose of outreach = increasing science literacy  
| Purpose of outreach = workforce development  
| Purpose of outreach = youth development  
| Purpose of outreach = complimenting formal education  
| Value of outreach = community development  
| Value of outreach = enhancing teachers' ability to serve students  
| Value of outreach = improving K-12 education  
| Value of outreach = influencing public opinion (about scientific issues)  
| Value of outreach = making community connections (networking) |
| Program Components - Structure | Cognitive Apprenticeship (seminar – instruction/discourse)  
| Community of Practice  
| Creative freedom & autonomy  
| Structured Reflection (interviews, seminar)  
| Templates/Resources (boundary objects)  
| Theoretical Framework  
| Traditional Apprenticeship (field component) |
| Program Components - Support | Fiscal support (for site visits, conference travel, etc.)  
| Social Support: Accountability  
| Social Support: Emotional  
| Social support: Intellectual  
| Technical Support (feedback/advising) |

<sup>1</sup> Perceptions of outreach and education are not divided into initial/final because there were not clear demarcations for all scholars. See case narratives for in-depth discussion of individual scholars’ perceptions before/after.