PURM
Perspectives on Undergraduate Research and Mentoring

Developing Expertise: An Apprenticeship Model of Mentoring Undergraduate Research Across Cohorts

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In a suburban middle-class home in a small town in the southeast, four-year-old Natalie and her mother are baking cookies together. As her mother sets out the ingredients, Natalie drags a chair over so she can be at counter level. Natalie watches eagerly as her mother breaks the first egg into the bowl and asks to help break the second one. Her mother helps Natalie crack the next egg carefully into a different small bowl, and when she determines that no shells have made their way into the mix, she pours Natalie's egg into the larger bowl. Holding the whisk together, they beat the egg mixture. Then they look at the recipe, talking about what to do next.

Nearby, at a university in the same small town, two students are preparing to collect data on parent-child interactions at a family home similar to the one described above. In the laboratory, Erin, then a senior, shows Lauren, then a sophomore, how to pack up the video camera, tripod, and all the materials necessary to conduct the study. Once inside the home, Lauren watches while Erin gives the parent and child instructions about the study. At this interview, Lauren is responsible for filming the interactions and observing how Erin conducts the developmental assessments of the child. In future sessions, she will practice giving the assessments while Erin watches and provides guidance.

Both of these scenarios describe a cognitive apprenticeship, in which learners gain knowledge from more experienced family or community members in the course of their interactions in a relevant social context (Rogoff, 1990). By participating in on-going daily routines and activities, learners gain experience with many different facets of a particular activity under the guidance of an informal tutor. This model is often employed by psychologists to characterize children's development but can also be applied to mentoring undergraduate research (e.g., Fair, King, & Vandermaas-Peeler, 2004; Hagstrom, Baker, & Agan, 2009). Faculty members and more advanced students provide guidance to novice researchers not only in more formal teaching contexts such as classes, labs, and meetings, but also informally through joint participation in research activities. The purpose of this paper is to describe the cognitive apprenticeship model as it applies to undergraduate research mentoring and to provide examples from our collective experiences as a faculty member (Vandermaas-Peeler), graduate students who participated in undergraduate research (Nelson and Ferretti), and an undergraduate researcher who just completed her senior project (Finn).

Cognitive Apprenticeship and Fostering Learning through Observation and Participation

Sociocultural theoretical frameworks emphasize the importance of studying children's learning through participation in everyday activities within the context of the family and the community (Lave & Wenger, 1991; Rogoff, 1990; Rogoff, 2003; Super & Harkness, 1986; Vygotsky, 1978). Rogoff and her colleagues described this family- and community-based learning as intent participation, or "learning by observing and pitching in" (Paradise & Rogoff, 2009, p. 104), and contrasted it with traditional formalized school practices in which children learn decontextualized information in a segregated setting. Intent participation emphasizes participation in activities of importance to the community in an embedded, contextualized process of learning. We employ a sociocultural framework in our studies of children's cognitive and social development in the context of informal interactions with family members in culturally relevant routines such as cooking, reading, and play (e.g., Vandermaas-Peeler, Nelson, Bumpass & Sassine, 2009; Vandermaas-Peeler, Nelson, von der Heide, & Kelly, 2009).

The model of undergraduate research mentoring described in this paper is also predicated on intent participation. Students become research apprentices and gradually learn to apply their course-based knowledge to myriad research activities in the lab and in the field (Fair et al., 2004). Historically, an apprenticeship meant a formal arrangement between a mentor and someone learning a trade with a prescriptive set of skills to be learned from an expert (Paradise & Rogoff, 2009). However, the term "cognitive apprenticeship" is used in this paper to refer to a formalized relationship between a professor as mentor to students engaged in undergraduate research with an emphasis on intent participation that includes developing expertise via collaborative learning in contextualized activities, not just learning processes in which an expert transfers knowledge to students.

Maureen Vandermaas-Peeler, Professor of Psychology at Elon University

Students at Elon University sign up for undergraduate research as a course with a specific faculty mentor. Every department on campus has a shared course number signifying undergraduate research. The students can take one to four credit hours a semester with a maximum of eight hours that can be counted toward degree requirements. Each credit hour corresponds to at least three hours of research work per week (see also Undergraduate Research at Elon). Students identify faculty mentors through a wide variety of formal and informal processes, depending on the department policies and the faculty mentors' preferences. Faculty mentors receive financial compensation or credit toward a course release based on the number of accumulated student credit hours. This formalized system underscores the value the institution places on undergraduate research and mentoring.

Most students begin working with me at the end of their sophomore year, and if we agree to continue the mentoring relationship, the students will generally work with me for the next two years. Although the credit hours vary, students normally take one to two credits per semester over approximately four semesters (allowing for study abroad or other contingencies). Elon also has the Summer Undergraduate Research Experience (SURE) program that provides eight weeks of intensive faculty-mentored research, and both students and faculty are compensated for this work. The SURE program is an excellent opportunity for students and faculty to extend and augment on-going research and is increasingly popular at Elon University.

All students working with me on undergraduate research during the academic year meet with me weekly to discuss readings and on-going research activities. Sometimes this meeting includes several students from different projects, and at other times individual meetings are required. Each student begins as a novice on an existing project led by more advanced students in order to gain basic skills and knowledge of the research paradigm. This apprenticeship may

take different forms depending on the specific project but generally proceeds as outlined below.

The students begin reading about the sociocultural theoretical framework of development as well as prior research on the topic of particular interest (e.g., development of numeracy skills in early childhood). In addition to reading relevant research articles, most students observe and eventually assist with on-going data collections and learn to develop and apply coding schemes to analyze complex human interactions. After the first semester, most students work with me to develop the next study on which they will take a leadership role. As a particular student develops expertise and specific skills on his or her own project, he or she will eventually work with a less advanced student and provide guidance in joint activities such as data collection. In this model of cognitive apprenticeship, each student has the opportunity to participate in the roles of both apprentice and guide and to work closely with other more advanced students and with me in a wide variety of research experiences.

"Mentoring relationships in undergraduate research involve more complexity in the roles than simply faculty expert and student novice."

Mentoring relationships in undergraduate research involve more complexity in the roles than simply faculty expert and student novice. Having spent nearly 20 years as a teacher-scholar, I often adopt the role of expert in my early interactions with students. One notable exception is with new technologies; often my students emerge as experts who guide me to new understandings. Students also serve as peer mentors and guide each other, and in the case of the three student co-authors on this paper, generations of students who have worked with me establish mentoring relationships with younger cohorts even when they are not undergraduates together. Joint participation in similar research opportunities enables all of us working together to gain more expertise than we had when we started, and more than any of us may have gained by working independently. Learning by collaborating and participating in a variety of activities is of great value to individuals within cultural communities (Lave & Wenger, 1991; Rogoff, 1990; Rogoff et al., 2003). In the context of an apprenticeship or side-by-side participation in undergraduate research, the lab group can be considered a community, and the individual learners become integrated participants in joint endeavors of importance and interest to the collective group.

As a faculty mentor, I involve students in all aspects of research, from the beginning planning stages to the culminating presentations and long-awaited publications of our work together. I work closely with students over the course of approximately two years, providing support and challenge in accordance with each student's developmental level. In my experience, matching students with appropriately challenging opportunities is a very important part of mentoring undergraduates. It is also important for mentors to facilitate undergraduate students' awareness of and engagement in a variety of professional opportunities (e.g., encouraging and helping them apply for grants, special research opportunities, and awards). Another aspect of mentoring is establishing a close working relationship with students. My students and I often share chocolate and laughter in addition to a heavy workload. I never underestimate the power of food to forge relationships! Another important facet of high-quality undergraduate research mentoring is to establish the connections between the research process and outcomes for students. The outcomes are tangible and intangible, ranging from academic successes (e.g., national presentations and publications, graduate school offers, and stipends) to socio-emotional benefits (e.g., supportive relationships with faculty and peer mentors) and personal growth (e.g., increased confidence and mastery of knowledge and skills).

In the subsequent sections, three students who have worked with me — two in graduate school at the time of writing and one who just graduated from Elon University — articulate the challenges and supports they encountered on their research paths. Their stories are written in their own words and provide authentic examples of this cognitive apprenticeship model.

Jackie Nelson, Class of 2006, Assistant Professor in the School of Behavioral and Brain Sciences, University of Texas at Dallas

I joined Dr. Vandermaas-Peeler's lab group in the midst of data collection during the spring of my sophomore year. The lab consisted of four seniors actively collecting data from home visits, transcribing videotapes, and coding mother-child interactions of reading and play activities. I had no previous experience with research but quickly learned the lab routine after a few weeks of training and mentoring by my more experienced lab-mates. They taught me skills that I would not have been able to learn from a textbook or in a classroom. For example, I learned how to look for subtle parenting behaviors while coding parent-child interactions and how to present myself and speak to families during home visits in order to maximize their comfort with the research process. That summer I was involved in the SURE program and continued to collect, code, and analyze mother-child play data.

In the fall, I took on a mentoring role as I was joined by two new students at the start of the next phase of data collection on the project: the addition of a low-income sample from local Head Start preschools. I trained the new lab members in the level of detail necessary while transcribing videotaped interactions and in developing a working coding manual as we worked on becoming reliable in our observational coding scheme. In accordance with the tenets of apprenticeship through intent participation, I found myself both setting an example for the new lab-mates in how to behave during home visits and also learning from them when we found ourselves in unfamiliar situations. Our work evolved into local, regional, and national conference presentations, Rawls funding (a special award for select students), a second SURE experience, and eventually publications in peer-reviewed scholarly journals (e.g., Vandermaas-Peeler, Nelson, & Bumpass, 2007; Vandermaas-Peeler et al., 2009).

Opportunities. Undergraduate research was instrumental in my success during and after Elon. As a student, I learned about the research process, formed a close bond with my mentor, and received funding to continue working on research during the summer months. With the help of my mentor and lab-mates, I also had the opportunity to present at the National Conference of Undergraduate Research (NCUR), where I was exposed to different research disciplines from around the country. I truly believe that without the opportunity to engage in in-depth undergraduate research at Elon, I would not have been as successful in my graduate application process or in my graduate program training. Throughout my four years in graduate school working in a large, federally funded research lab, I have noticed formal and informal advantages directly stemming from my undergraduate research involvement. I am very familiar not only with the research process and the presentation of research findings but also with the apprenticeship model, which is a large component of graduate student training.

Challenges. One challenge that we faced while conducting research on families was the homogeneous middle-class population in the immediate area. It is no longer acceptable for researchers to ignore issues of ethnic and financial diversity in research samples; however, it can be difficult for undergraduate students to obtain willing participants outside of the Elon University community. In one project, we had a specific goal of collecting data from low-income populations. We were able to attain this goal to some degree by calling on the personal connections one of the lab members had from growing up in a nearby town. In addition, undergraduate research funds provided incentives. Without the financial support and personal networking, this challenge would have been difficult to overcome.

Suggestions. The undergraduate research program at Elon provides countless benefits to students that continue for many years after graduation. It is important that universities continue to fund undergraduate research, both in terms of students' time during the summer months as they make progress on their personal research projects and in terms of facilities, equipment, research materials, and payment for research participants. Without funding opportunities, undergraduate research cannot remain competitive for national conferences and journal publications.

In addition, it is important that undergraduate research programs help facilitate connections between the university and local communities. Research on human subjects is dependent on student-community cooperation. Community organizations and institutions, such as elementary schools, preschools, and after-school programs, need to be able to trust that undergraduate students will conduct ethical research with the participants' best interests in mind. One way to build trust and connections would be to host public forums where college students were able to share their research findings with community members and discuss ways to use results to better serve the area.

Larissa Ferretti, Class of 2009, Graduate Student in Department of Human Development and Family Studies at Auburn University

As a sophomore undergraduate researcher, I worked under the guidance of a senior Honors Fellow (Jessi Young) collecting, transcribing, and coding data for a study exploring mothers' and fathers' guided participation in reading and play interactions with their preschoolers. By working in collaboration with advanced students, I was able to learn about the undergraduate research process through direct teaching, but more importantly through observation and experience. While I was reading the basic literature in the field, my colleagues were excitedly fitting models and obtaining results for their projects. This equilibrium within the lab of both new and old, beginning and end, encouraged a constant sharing of ideas and experiences. From this work, I became interested in preschoolers' numeracy acquisition during everyday activities. Thus, for my Honors Fellows thesis I investigated the influence of parental guidance on emergent numeracy during game playing.

I began focusing on my own project and transitioning into a more advanced role in my junior year. That summer I spent eight weeks working full-time on my thesis project through Elon's SURE program. In the spring of my junior and senior years, I presented research projects at Elon's student conference, the Student Undergraduate Research Forum (SURF), Posters on the Hill, and NCUR. My undergraduate research experience culminated in the completion of my Honors thesis in the spring of my senior year.

Opportunities. The apprentice model encouraged cross-cohort relationships critical to my research experience. First, although our projects were very different, my relationship with Jessi provided necessary guidance through the undergraduate research experience. I was able to observe Jessi's successes and roadblocks, as well as discuss them with her and our mentor during our weekly lab meetings. I could feel comfortable going to her with questions about the research process, my relationship with my mentor, and graduate school, among other concerns. Before conferences, Jessi and I would practice our presentations together, and she would provide tips on presentation style. Importantly, when our mentor could not be at our national presentations, I would look for Jessi in the audience to provide assurance or to ask an intriguing question following my talk. Jessi was undoubtedly an outstanding role model of a successful undergraduate researcher, and her successes encouraged and challenged me not only to work hard to develop my research but also to spend time developing the research skills of others.

Second, while I was applying to graduate school, my mentor was able to connect me with a former student (Jackie Nelson) who introduced me to the field in which I now study. While Jackie and I were never members of the developmental lab during the same academic year, she provided pivotal guidance

regarding her graduate school experiences. I first met Jackie at a Psi Chi (Psychology Honor Society)-sponsored graduate school information session where three Elon alumni spoke to undergraduates about their graduate school application process and their current graduate school experiences. In that session, Jackie was a student mentor to many Elon students. I was privileged to have a later lunch date with Jackie and our mentor to further discuss my future career goals. Jackie spoke of how her experiences as an undergraduate researcher at Elon led her to her current program. I decided to apply to the program Jackie was attending, and when I went to visit the school, she was there to give me a tour and introduce me to other graduate students. Without these connections between my mentor and her former undergraduate researcher, I would be on a very different path.

Challenges. All undergraduate researchers face challenges along the way. One of my biggest challenges was patience. When I entered the lab, I was instantly ready to begin work on my own study. In fact, I sometimes felt I was wasting valuable time helping the more advanced students complete their projects. I knew I was learning valuable skills, but I felt I was ready to apply them to my own project much sooner than I was permitted to do so. The Honors Fellows program demands excellence on an individual project and, during the time of being an apprentice, it was sometimes difficult to remember that I was making progress while working under a more advanced student.

In addition, while I spent almost 1.5 years on my independent thesis project, I could not use all of the data and answer all of the research questions. However, this challenge quickly turned into an opportunity for future undergraduate research students. During my first semester of graduate school, I was able to guide another undergraduate researcher who is now continuing the project. Inviting future students to take over the project not only solved the issue of time but also allowed for more funds to be gathered and the project to be expanded.

Suggestions. I suggest that professors allow time during lab meetings or individual meetings with students for discussion beyond lab procedures. Time spent talking about research experiences or graduate school applications is never wasted. For faculty mentors, the product is as much the student as it is the project. This may be the first time a student has considered a graduate school education, and time spent sharing with them is vital.

I suggest that students take ownership of the project(s) they work on, whether serving as an apprentice or as a more advanced student mentor. Working under a more advanced student will provide a knowledge and skills base essential to successful research. In addition to possibly discovering and honing research interests, student mentors can assist with general research processes such as presentation and writing style. Furthermore, beyond the research process, these relationships are vital to career building. Without my cross-cohort relationships, my knowledge of possible program choices would have been severely limited, and I would not be at Auburn University today. Most importantly, ask — whether it is for funding, feedback, or assistance. Asking for help along the way not only improves the project but also improves the researcher's skills. Last, students should maintain a close relationship with their faculty mentors. My mentor has remained a vital source of support as I pursue my graduate degree. The relationships one can develop during an undergraduate research experience will provide opportunities for years to come.

Lauren Finn, Class of 2011, Recent Graduate of Elon University

I came into the developmental psychology lab during the spring of my sophomore year. I began shadowing a senior on her project, helping with data collection and observing coding all while beginning to get a background in the literature. I was assisting with a project observing parent numeracy teaching during a cooking task. This initial experience spurred my interest in the teaching behaviors that occur during cooking, and I eventually used this model in the construction of my own

research project. My senior research project involved observing the effects of siblings on engagement, attention management, and parent teaching behaviors during a cooking task with a four-year-old.

Opportunities. If it were not for the apprenticeship model, I believe my background in developmental psychology would not be as strong as it is. Observing and assisting seniors with their projects allowed me to experience the process of constructing and completing research firsthand. I had the opportunity to observe data collection methods and the struggles of creating a reliable coding scheme. Without this experience I would have been jumping into my own research project completely unaware of the trials that were ahead. Already having some knowledge of data collection, coding, and the problems that are often faced within these two aspects of research truly helped me in the construction of my own project. Having prior experience and knowledge allowed me to make informed decisions about my project.

An additional opportunity the apprenticeship model allowed me was the use of previous data that I helped to obtain as part of my own study. Thanks to my experience as an apprentice in the lab, I was familiar with a former student, Erin Boomgarden's, numeracy study. I had helped her with data collection and observed her coding sessions and became very familiar with her data. Through this process, I realized I was interested in looking further into some behaviors in her data that were not fully covered in her coding scheme. Because of this apprenticeship model, I was able to go back and re-code that data on my own to find significant results and eventually present my findings at a national conference. If I had never been an apprentice helping with Erin's study, I would never have had the opportunity to observe such interesting behaviors and to extend her work and apply my own questions of interest.

Challenges. One of the major challenges for me was developing my coding scheme. After being an apprentice in the lab for so long, I was excited to be advancing my own project. However, when I got to coding, the research process involved looking back at prior coding schemes, and progress on my own coding was very slow. This process was very frustrating for me. I have realized that a coding scheme does not automatically come to you on your first attempt; it takes a lot of trial and error to get a reliable coding manual. For me, this process involved looking back into previous studies in the lab to see what worked well and what did not. Making so much progress on my individual study and then having to go back into previous studies was a challenge at the time, but I now realize how those previous studies truly helped to make my current study the best it can be. I needed the experience of looking back in order to move forward with my research.

Further, another challenge of the apprenticeship model is students initially may not feel as though they are making progress on their own study. As an Elon College Fellow, this was a concern to me because I needed to complete an independent research project as part of my requirement. During my first few semesters in the lab, I sometimes felt frustrated that I was always helping out on someone else's project and not making much progress with my own. Although at the time this was a challenge, I have come to realize that this period spent as an apprentice was beneficial to my individual research. As a sophomore, I got hands-on experience without yet creating my own project. I developed my interests in developmental psychology by observing seniors working on their projects. I had the opportunity to observe developmental research while also getting a foundation in the literature. Although this process seemed tedious and did not have immediate results for me, I have realized now that this aspect was more of a benefit than a challenge.

Suggestions. For anyone getting involved in the apprenticeship model of research, I would advise them that although being an apprentice may not immediately give a sense of ownership of a project, it will provide the background and tools necessary to create an outstanding research project. It is important to stick with the sometimes tedious and unsatisfying apprentice work because it will make students better researchers with a

keener eye for what research is needed in the field.

I came into the lab without much background knowledge of developmental psychology. I knew that projects coming out of the lab sounded interesting and that I really enjoyed a cognitive development class that I took freshman year. This interest led me into working as an apprentice in the lab, and I can now say that I am confident in my ability to develop research methods, have an informed discussion of the current literature in developmental psychology, and complete an undergraduate research project of my own creation. Two years ago this was something I never would have imagined for myself, but thanks to the apprenticeship model, I was able to gradually scaffold my knowledge and participation in the lab into a coherent and independent research project.

My advice to research students is to stick with this model because, at least in my experience, it works. Students should find a field of undergraduate research they are interested in, and get involved. They probably will not jump immediately into their own project, but they will learn a lot from their peers at varying stages of the research process. Getting involved as an apprentice will give students the opportunity to work on projects they are interested in and the research methods involved in these projects. This is a resourceful background to have before jumping into their own projects, and I do not know where I would be in my research career without it.

Faculty Perspective and Conclusions

Despite differences in their specific projects and individual experiences, common themes supporting intent participation and cognitive apprenticeship emerge in the students' descriptions of their research experiences. Jackie, Larissa, and Lauren all became involved in extant research projects as apprentices in their second year, which fostered their knowledge and sense of connectedness to the lab and other students. This served as a foundational experience that led to more in-depth research in subsequent semesters, in which they were leaders. All three were selected to participate in SURE, an intensive eight-week experience in the summer in which they worked closely with me and also were part of a small cohort of other students who were highly engaged in research. They all presented their work at national conferences, sometimes on multiple occasions, and they all have been or will be co-authors on publications in scholarly journals. Their participation in undergraduate research influenced their career decisions and enhanced professional opportunities. There were socio-emotional gains embedded in their accounts as well, including increased confidence, pride, and a sense of being connected to a supportive community of scholars. Learning that occurs within a similar community of individuals fosters personal and emotional commitment and a sense of belonging and connections to a larger culture (Paradise & Rogoff, 2009).

Faculty mentoring is critical for high-quality undergraduate research experiences, and in the apprenticeship model, peer mentoring and collaborative learning are key to students' development (Rogoff et al., 2003). One source of student frustration with the apprenticeship model that has deepened in recent years is increasing ownership of individual projects (e.g., the Honors thesis) that are sometimes viewed as "individual" accomplishments. Students who know they must complete their "own" project are increasingly reluctant to work on "someone else's" project, and this limits opportunities and openness toward side-by-side participation that is critical for immersed and engaged collaborative learning. Program directors and faculty mentors may want to emphasize developmental differences in undergraduate research participation, and frame students' experiences over time (Vandermaas-Peeler & Miller, 2010). Students in early stages of the project may expect and require more guidance and would benefit from peer and faculty mentoring, whereas students in later stages of research may work more independently and take ownership of a particular project or a research question embedded within a larger study.

In this paper, we have described a cognitive apprenticeship model applied to undergraduate research mentoring in the framework of an observational, field-based research program in psychology. Cognitive apprenticeship is also possible in a variety of other disciplines, though the model may not appeal to all. For example, students in archaeology often begin as apprentices on a field site and work closely with both graduate students and faculty members to learn the appropriate skills. Students in biology may work in pairs or small groups in laboratory and field settings, and pairing novices with more experienced students and faculty facilitates learning. Colleagues in exercise science and human service studies employ a very similar model of apprenticeship to the one described here. Creative projects may also benefit from shared experiences and collaboration across cohorts or student experience levels. For example, students working in theater design or documentary production often work as apprentices in the early stages of their projects. Learning by observation and collaboration is a key part of intent participation (Rogoff et al., 2003) and can be applied to myriad undergraduate research contexts.

Can an apprenticeship model of undergraduate research mentoring focused on joint participation and collaboration in a variety of research experiences be utilized within and across cohorts? The stories of these three young women illustrate their gradual transformations from apprentices to experts and the inter-generational mentoring they experienced. The cognitive apprenticeship model provides one pathway that deepens and sustains student engagement in undergraduate research.

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