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Research Report

What does a Modern Anatomist Look Like? Current Trends in the Training of Anatomy Educators

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ABSTRACT

Anatomical sciences are foundational to the health professions, yet little is known about the qualifications of anatomy educators at the graduate and professional level in the United States. Moreover, there is concern that the number of qualified anatomy educators being trained may be insufficient to meet the growing demand posed by new and expanded programs in medicine and allied health specialties. The authors surveyed anatomists from across the country to (1) characterize the educational credentials of current anatomy educators and (2) assess the perceived need for education-focused postdoctoral positions or formal mentorships to prepare anatomists for teaching-intensive faculty positions. To probe the survey responses more deeply, one-on-one interviews were conducted with eight individuals selected to represent a diverse sample of respondents in terms of institution, gender, and academic rank. Results indicate that 30-40% of educators at the graduate level and approximately 60% of those at the undergraduate level lack graduate coursework in histology, embryology, and neuroanatomy. Forty-five percent of respondents had completed a postdoctoral fellowship. Eighty-six percent replied “yes/maybe” to the question of whether an anatomy education postdoctoral fellowship would benefit doctoral graduates. The top 3 reasons for this recommendation were to (1) establish independent educational research, (2) improve a publication record, and (3) gain additional teaching experience. Notable weaknesses of education-focused postdoctoral training were related to finances, fear of exploitation, and undervaluing of teaching. Moving forward, postdoctoral fellowships and other forms of postgraduate training may represent a key strategy for training anatomists in the current educational climate.

Key Words: gross anatomy education, medical education, graduate education, anatomy training, postdoctoral training in anatomy,

INTRODUCTION

The anatomical sciences provide the underpinning for virtually all medical and allied health specialties as well as a number of non-medical disciplines such as anthropology and kinesiology. The teaching of the anatomical sciences, therefore, is paramount to all levels of the educational system from elementary school to graduate and professional training. The *National Science Education Standards* (National Research Council, 1996) recommend that human organ systems be studied in middle school (grades 5-8), and the science standards of some states call for introductions to anatomy as early as third grade (Alabama Department of Education, 2015). In the high school years (grades 9-12), science elective courses concentrated in anatomy are commonplace. Furthermore, preparatory coursework in anatomy is a prerequisite for most undergraduate (e.g., nursing, dental hygiene, radiation technology) and graduate (e.g., physician assistant, physical therapy, occupational therapy, pharmacy) professional programs in the health sciences and is recommended for study in advance of admissions tests [e.g., Dental Admissions Test (DAT), Medical College Admissions Test[®] (MCAT[®])]. The widespread need to disseminate anatomical knowledge to learners hinges on the premise that educators at all academic levels will be qualified and equipped to effectively impart such knowledge and that adequate numbers of anatomy educators will be available to do so.

Literature over the past 15 years has called into question whether a sufficient number of new anatomy educators are being trained to meet the instructional needs of society (Holden, 2003; Santana, 2003; McCuskey et al., 2005; Hedger, 2009; Yammine, 2014). A number of factors have been cited as contributing to this apparent shortage, including the move from discipline-based to integrated medical curricula. Additionally, a paradigm shift in graduate biomedical training has led to a move away from producing anatomy or physiology generalists to

cultivating specialists highly concentrated in one research area (Rizzolo and Drake, 2008; Brokaw and O'Loughlin, 2015). This is no doubt a consequence of the challenging economic realities confronting our nation's medical schools and academic health centers (Dzau et al., 2013; Stimpson et al., 2014). Funding from the National Institutes of Health has fallen dramatically in recent years (Alberts et al., 2014), and publically supported medical schools have seen their state funding steadily dwindle as a percentage of the school's operating budget (AAMC, 2016). Over time, anatomy departments have adapted to these prevailing financial pressures by focusing their recruitment efforts on faculty researchers who are able to subsidize their salaries with external grants rather than by hiring anatomy educators, whose salaries must be funded by internal sources. As classically trained anatomists began to retire in the early 2000s, it became apparent there would likely be a decade-long shortage of qualified anatomists. Interestingly, this shortage coincides with a rise in the use of non-faculty instructors (with diverse backgrounds, qualifications, and teaching experiences) to fill teaching roles in higher education (Halcomb et al., 2010; Caruth and Caruth, 2014; Rhodes et al., 2018). In an attempt to reduce shortages in anatomy educators specifically, new Ph.D., postdoctoral, and continuing education training programs focused on anatomy education have begun to surface (Albertine, 2008; Fraher and Evans, 2009; Bader et al., 2010; Brokaw and O'Loughlin, 2015; Doss and Brooks, 2016).

As the old adage states, "there's more than one way to skin a cat"; there is also more than one way to train an anatomist. The American Association of Anatomists website (2017) and a publication from Brokaw and O'Loughlin (2015) indicate that a number of master's and doctoral level training programs in anatomy exist in the United States, Canada, and Europe, though the combined total number of graduates developed by these programs each year is unclear. Ph.D. programs such as those at Indiana University (Brokaw and O'Loughlin, 2015), the University of

Mississippi (2017), Louisiana State University (2017), Pennsylvania State University (2017), Boston University (2017), University of Nebraska (2017), and Western University (2018) provide students with training in anatomy and teaching experience in the anatomical sciences alongside their dissertation research. Like Ph.D. programs, master's degree programs typically vary from anatomy-focused instruction (such as the M.S. in Contemporary Human Anatomy at Eastern Virginia Medical School (2017) and the M.Sc. in Human Anatomy at University College Cork (2017)) to general biomedical sciences (such as the M.S. in Biomedical and Health Sciences at the University of Alabama at Birmingham (2017)). While many of these master's-level training programs are designed as segues to medical and dental school, the training provided often includes a significant anatomy focus and thus could be used as instructor preparation. Continuing education also represents a tenable method for training future anatomy educators (Fraher and Evans, 2009; Wilson et al., 2018) though its focus has primarily been on high school and undergraduate educators thus far (Burns, 2002, 2008; Doss and Brooks, 2016). Finally, postdoctoral fellowships in anatomy education are yet another potential method for training competent anatomy educators. Though now discontinued, Vanderbilt University once offered the Medical Science Educator fellowship (Bader et al., 2010), and a small group of other anatomy-focused postdoctoral fellowships are currently in existence, though most are in their infancy. While postdoctoral fellowships and continuing education activities with an anatomy focus are uncommon, there are a growing number of programs in medical education and medical education research that could provide needed training for individuals who have been previously trained in the anatomical sciences (HMI, 2017; McGill University, 2017)

The question remains, "What qualifies an individual to be an anatomy educator?" Unlike the health sciences clinical arena where each profession is credentialed or licensed by a

governing body (e.g., State Medical Board) and the K-12 sector where teachers are certified at the state-level, no standards or licensures exist for educators in the anatomical sciences at the collegiate and graduate levels. A decade ago, discussions were held by attendees at the American Association of Anatomists annual meeting regarding the credentialing of anatomists (Rizzolo and Drake, 2008). Three major needs emerged from these sessions: (1) the need to identify the skills and knowledge shared by anatomists, (2) the need to address historical inattention to the training of anatomy educators, and (3) the need to support the training and work of anatomy educators. In 2013, the Human Anatomy & Physiology Society (HAPS) in conjunction with members from the American Association of Anatomists, American Association of Clinical Anatomists, and American Physiological Society issued a whitepaper detailing recommended criteria for the evaluation of collegiate anatomy and physiology instructor qualifications by accrediting bodies (HAPS, 2013). The position statement identified recommended minimum qualification for teaching introductory anatomy and physiology courses as (1) a master's degree in a life science or clinical discipline, and (2) 18 credits from relevant coursework (undergraduate or graduate), research, clinical work, or continuing education. Despite these efforts, little progress has since been made to characterize and quantify the requisite qualifications of educators in the anatomical sciences at the graduate and professional level.

In order to provide current and relevant information to stakeholders, this study set out to characterize the current landscape of anatomy educator training at the national level. The first major goal was to characterize the type and level of training that current anatomy educators at all levels possess so as to better gauge the qualifications and credentials of anatomists. Secondly, the study evaluated the perceived need for anatomy education postdoctoral fellowships in preparing educators for faculty positions in large, medical universities. Lastly, the study assessed the

potential value of anatomy-focused postdoctoral training. These research goals are framed around the hypothesis that modern anatomists require expertise in anatomical content, pedagogy/adult learning theory, and research (science- or education-based) and that tailored postdoctoral fellowships or formal mentoring programs may be a mechanism for filling identified training gaps.

METHODS

Survey Distribution and Features

The data compiled for this study were acquired through the distribution of two national surveys. The goal of the ‘*anatomy educator survey*’ was to assess the type of education and training that current anatomy educators at all levels possess. This survey has been previously described by Wilson et al. (2018). To recapitulate, “The survey was distributed to a broad and diversified audience of educators who teach content related to the anatomical sciences. The target audience ranged from science educators in secondary education to anatomy professors at medical institutions. Responses from high school science educators were solicited through both national and state level science teacher associations (e.g., National Science Teachers Association, Society for College Science Teachers, etc.). Anatomy faculty at institutions of higher education (including, but not limited to, allopathic and osteopathic medical schools) were invited to participate in the survey via list-serves or message boards hosted with nationally recognized societies (e.g., Anatomy Connected sponsored by the American Association of Anatomists and the Human Anatomy & Physiology Society) (Wilson et al., 2018).

The goal of the ‘*anatomy education postdoc survey*’ was to assess the perceived need for anatomy education postdoctoral positions that would help facilitate the transition from graduate

student to productive faculty member. The survey was conducted in two phases. In the pilot phase, solicitation e-mails with an embedded survey link were sent to a convenience sample of known anatomy educators in teaching-intensive faculty positions at institutions of higher education. Based on their responses and recommendations, the survey was modified and redistributed to a broader range of potential participants via the Anatomy Connected message board sponsored by the American Association of Anatomists. To probe the survey responses more deeply, several individuals were invited to participate in one-on-one interviews conducted via the Zoom teleconferencing platform ([Zoom, 2018](#)). Individuals were strategically selected to represent a reasonably diverse sample of respondents in terms of institution, gender, and academic rank. In total, eight semi-structured interviews (~30 minutes each) were conducted. The interview questions mimicked the open-ended survey items, thereby allowing participants' responses to be cross-referenced in order to verify the opinions held by interviewees.

Survey response rates could not be accurately computed for either survey due to multisource survey distribution (i.e., circulation via society list-serves, message boards, blogs, email, etc.), which precluded an accurate accounting of the total population of eligible participants. A maximum *anatomy educator survey* response rate is estimated at 27%. Survey reminder notices were sent at roughly two- and four-week intervals. Study protocols were approved by the institutional review boards of Indiana University and the University of Alabama at Birmingham (Protocol Numbers: 1607805248 (IU) and E161227001 (UAB)).

Data Analysis

Quantitative Analyses: Responses for both surveys were collected through Qualtrics (Qualtrics, Provo, UT). Both datasets were exported to Microsoft Excel[®] (Microsoft Corp.,

Redmond, WA) for organization and cleaning, and SPSS statistical package, version 22 (IBM Corp, Armonk NY) was used for computing statistical procedures. In addition to reporting descriptive statistics for all survey items, a Kendall's tau-b analysis investigated the strength of the association between respondents' highest reported degree and the number of graduate level credit hours earned in the anatomical sciences. This same procedure was also used to explore whether an association existed between highest degree attained and the highest level of learner taught. An independent samples t-test compared the number of disciplines taught by anatomy educators who had formal mentorship training versus those who had no mentored experiences. Lastly, either a Pearson's Chi-square test or a Fisher's exact test was used to evaluate differences in perceptions about anatomy education postdoctoral training between respondents categorized according to certain characteristics (e.g., whether or not respondents had postdoctoral training, tenure versus non-tenure track status, etc.).

Qualitative Analyses: Open-ended survey responses and transcribed interviews were independently coded for themes by two members of the research team (A.F.S. and J.B.B.) using the Dedoose qualitative analysis platform (Dedoose, 2018). The thematic analysis consisted of six iterative steps: (1) Survey responses and interview transcripts were read with the research questions in mind; (2) A set of codes (brief descriptors of responses) were developed from the narrative data; (3) Two independent readers applied the derived codes to the responses; (4) The two sets of independently coded responses were reviewed for consistency, and, if necessary, codes were refined and discrepancies were settled; (5) Themes were developed based on the coded responses; and (6) The identified themes were used to re-read the responses from a new theoretical lens to ensure the meaning of each response was fully captured, based on the researchers' interpretation (Braun and Clarke, 2006; Guest et al., 2012).

RESULTS

Anatomy Educator Survey – Quantitative Findings

Certain descriptive demographics from the anatomy educator survey can be viewed in a prior publication (Wilson et al., 2018). In summary, respondents' teaching experiences were equally distributed across categories (1-5 years, 6-10 years, etc.), and responses from across most U.S. states were representative of a breadth of educators from those teaching middle school students to those educating practicing professionals. Of the anatomy educators who responded to the survey, 55% (183 of 333) indicated their highest earned degree was a doctorate (Ph.D., M.D., D.O., D.D.S., D.V.M., Ed.D., D.P.T., etc.) and 39% held a master's degree. Courses taught by respondents included human gross anatomy without (19%, 64 of 337) and with (42%, 142 of 337) cadaveric dissection/prosection, combined human anatomy and physiology (51%, 171 of 337), neuroanatomy (18% 61 of 337), histology (19%, 63 of 337), embryology (19%, 65 of 337), and comparative/vertebrate anatomy (5%, 17 of 337). The percentage of undergraduate and graduate educators having earned graduate credits in each of the four anatomical disciplines is depicted in Figure 1. Not surprisingly, graduate level credit hours in the anatomical sciences were found to be significantly and positively correlated ($p < 0.001$, $r = 0.328$) with respondents' highest degree earned. Likewise, the highest level of learner taught by respondents was strongly correlated ($p < 0.001$, $r = 0.559$) with the highest degree the anatomy educator had earned. Three-quarters (104 of 138) of anatomy educators who cater to graduate and professional students reported teaching in at least two anatomical disciplines. Conversely, a single anatomical discipline was taught by most undergraduate (73%) or middle/high school educators (78%).

Overall, 26% (84 of 325) of respondents indicated they had had formal mentorship training in the anatomical sciences beyond the requirements of typical graduate course work. The majority of these mentorships (62%, 52 of 84) lasted longer than one year and occurred while the individual was a junior faculty member (56%, 40 of 72). Upon analysis, anatomy educators who engaged in formal mentorships reported teaching across a greater number of anatomical disciplines ($p < 0.001$; Cohen's $d = 0.219$) than those who had no mentorship experience.

Postdoctoral Survey – Quantitative Findings

Respondents of the postdoctoral survey mostly graduated from R1 doctoral research universities (73%, 47 of 64) and had doctoral preparation in either anatomy/cell biology or anthropology (78%, 50 of 64; Table 1). Assistant professors (44%, 28 of 64) were better represented than associate and full professors combined (41%, 26 of 64; Table 1). In total, 45% (29 of 64) of respondents indicated they had five or more years of experience in their current position, and a minimum of one-third (21 of 64) held tenure track positions. Nearly half of the respondents (45%, 29 of 64) had previously completed a postdoctoral fellowship. Notably, almost three quarters (72%, 21 of 29) of those who completed a postdoctoral fellowship had finished graduate school greater than 10 years ago, while 83% of those who did not complete a postdoctoral fellowship graduated within the last 10 years. When asked whether an anatomy education postdoctoral fellowship would be beneficial for recent doctoral graduates seeking careers as full-time anatomy faculty, a large majority (86%, 55 of 64) replied “yes/maybe” (Table 1). When respondents were asked to select the top three elements they felt would be critical for transitioning graduate students to the role of assistant professor, an outlet for establishing an independent educational research program and improving one's publication

record were the most frequently cited at 53% (31 of 59) and 51% (30 of 59), respectively (Figure 2). Research-related reasons for pursuing a postdoctoral fellowship were closely followed by a desire for more teaching experience and greater knowledge of teaching practices (Figure 2).

After grouping respondents based on various characteristics, their perceptions regarding an anatomy education postdoctoral fellowship were compared. For example, postdoctorally trained individuals were compared to those with no postdoctoral training to determine whether their opinions differed in recommending postdoctoral training for newly minted Ph.D. graduates. Across all comparisons made in Table 2, no significant differences were detected, meaning that respondents' perceptions were independent of their grouping characteristics.

Postdoctoral Survey and Interviews – Qualitative Findings

Open-ended survey items allowed respondents to elaborate on why they did or did not complete a postdoctoral fellowship. In all cases, interview and open-ended survey responses by the same individuals were well-aligned and no competing responses were identified. The primary reasons given for not completing post-graduate training were a lack of available/relevant fellowships and the notion that postdoctoral work was not necessary to become gainfully employed. In contrast, respondents who had completed postdoctoral fellowships in traditional bench science disciplines often explained these fellowships were typically required and were the accepted norm. A minor theme to emerge from the survey responses was the notion that teaching and educational research may lack value in the tenure and promotion process at many institutions, calling into question the value of spending the time to develop skills through an anatomy education postdoctoral fellowship which may not serve to propel an individual's career forward in the long-run.

Survey and interview data regarding the strengths and weaknesses of anatomy education postdoctoral fellowships are presented in Tables 3 and 4, respectively. The identified advantages of offering an education focused fellowship generally fell into three major categories (Table 3). The first category underscored the role of these programs in helping new graduates to establish themselves as independent educational researchers (including learning new skills and developing a publication and grant record). Secondly, fellowship programs help trainees to manage the responsibilities of a faculty position (including time management, politics and bureaucracy, and navigating the hidden expectations of faculty). This notion was further supported by interviewees who emphasized that an important skill to develop in early career faculty is learning to balance teaching and research expectations, as it typically seems there is never enough time for either task. Relatedly, interviewees expressed the value of quality mentorship in developing certain skillsets and navigating the bureaucracy of academia. This is in contrast to non-mentored, on-the-job training many participants reported having experienced. Thirdly, education-focused fellowship programs increase the credibility of ‘educator-scholar’ as an academic career path.

The weaknesses identified by participants relating to education-focused postdoctoral training (Table 4) tended to fall into the following categories: (1) financial challenges (including challenges for the department offering the fellowship and the fellow completing it), (2) fear of exploitation (i.e., the possibility of using the postdoctoral fellow as a ‘low-paid teacher’ and not allowing him or her to pursue independent research), and (3) a perceived undervaluing of teaching and educational research.

DISCUSSION

By surveying and interviewing a cross-section of the nation's anatomists, the present study has characterized the educational qualifications of the current anatomy education workforce and assessed the opinions of anatomy educators in teaching-intensive faculty positions about the career value of postdoctoral training or formal mentorship in anatomy education. This study thereby provides empirical data that can be used to guide the formation of new training programs to alleviate the perceived insufficiency of qualified anatomy educators at institutions of higher education (Holden, 2003; Santana, 2003; McCuskey et al., 2005; Hedger, 2009; Yammine, 2014). Because anatomists come from diverse backgrounds, work in diverse settings, and instruct diverse learner groups, modes of training that are novel, creative, and perhaps individualized may be necessary to bring a graduate to the point at which he or she is fully competent to meet educational responsibilities, which often change over time.

As new biomedical knowledge increases and medically-related technology advances at a rapid pace, anatomy educators and anatomy training programs must be adaptive in order to provide relevant instruction to their learner populations. Recent years have seen a change in the way the anatomical sciences are taught in medical schools (Schmidt, 1998; Muller et al., 2008; Cook et al., 2010). While historically the anatomical disciplines were largely taught as stand-alone courses (e.g., Gross Anatomy and Embryology, Histology and Cell Biology, Neuroanatomy), now integrated / systems-based curricula are commonplace (Heylings, 2002; Brooks et al., 2015; McBride and Drake, 2018). As anatomy education continues to become integrated with other basic science disciplines and with clinical medicine, educators are increasingly being called upon to teach beyond their areas of expertise (Muller et al., 2008). As such, it could be argued that newly trained anatomists should possess a breadth of knowledge that extends beyond the four anatomical disciplines in order to find their place within these

evolving curricular models. For example, healthcare has become increasingly reliant upon medical imaging, and as such ultrasound has joined plain film radiography and cross-sectional imaging (i.e., computed tomography (CT) and magnetic resonance imaging (MRI)) as a mainstay in clinical anatomy training (Hoppmann et al., 2011; Bahner et al., 2014; Martinez et al., 2015; Dinh et al., 2016a,b). A recent survey by Royer (2016) demonstrated that most anatomists are in favor of utilizing ultrasound in anatomy education, but 65% of survey respondents had minimal, if any, experience with ultrasonography. The continued clinical reliance on imaging modalities underscores the need for anatomists to be competent in teaching various forms of medical imaging, and evidence has shown that anatomists are as capable as clinicians in teaching ultrasound-based anatomy (Jurjus et al., 2014). The question remains, what avenues are available for anatomy educators to acquire these skillsets, and is graduate coursework alone enough?

The present survey of current anatomy educators regarding graduate coursework in the anatomical sciences revealed interesting findings. Not surprisingly, educators who instruct primarily graduate and professional students are more likely to have higher-level degrees and to have more graduate coursework in the anatomical sciences than educators who instruct only undergraduates. It is noteworthy, however, that approximately 60% of undergraduate instructors lack any graduate coursework in histology, embryology, or neuroanatomy regardless of whether they hold a master's or terminal degree. Even at the graduate level, close to 40% of anatomy educators lack graduate coursework in these disciplines. This apparent deficiency in graduate training comes at a time when new health professions programs are proliferating and further increasing the demand for qualified anatomy educators. For example, coursework in neuroanatomy is an accreditation requirement for both the doctor of occupational therapy (ACOTE, 2013) and doctor of physical therapy (CAPTE, 2018) degrees. Furthermore, almost

half of surveyed undergraduate instructors lack graduate credits in gross anatomy. Because graduate degrees are required for all instructors at either the undergraduate or graduate level, this means that many such instructors likely received a portion of their anatomy training through other mechanisms. Non-traditional methods of training thus represent an important and significant means by which faculty are becoming qualified anatomy educators. Examples of these alternative methods were highlighted by HAPS (2013) in the position statement put forth on the credentialing of anatomy and physiology educators as mentorship, teaching experience, continuing education (CE), research leading to publication, and clinical experience.

Continuing education may be one of the more practical methods for obtaining competence as an anatomy educator. Continuing education is flexible both in that individuals can enroll in specific courses to meet targeted needs and in that courses can be taken without disruption of normal job responsibilities through distance learning or over short periods of intensive training. Unfortunately, a recent survey revealed that while 81% of anatomy educators felt they had a need for CE in the anatomical sciences, few programs currently exist nationally to fill this need (Wilson et al., 2018). As stated before, being a competent modern anatomy educator may require more than just content expertise. Continuing education programs in educational methodology, pedagogy, and ultrasound have been identified as important to anatomists (Wilson et al., 2018) and are viable methods of professional improvement (Supovitz and Turner, 2000; Mattheis and Jensen, 2014). Similarly, CE in educational research may be a feasible method for filling gaps in faculty members' research portfolios (Hunt et al., 2008). As such, continued investigation into the availability and efficacy of CE opportunities for anatomists, including opportunities for developing medical imaging skills, is a potential direction for future research.

As the landscape of medical and health professions education continues to evolve, the experiences of applicants to be hired into anatomy faculty roles have also shifted. In this study sample, most individuals who graduated within the last 10 years did not complete a postdoctoral fellowship yet were successful in securing faculty positions. It is possible that the respondents who graduated 10+ years ago (most of whom did complete postdoctoral training) pursued more traditional, research-focused faculty positions, while the respondents who graduated in the recent decade sought teaching-focused positions that did not come with the expectation of postdoctoral training. This may also represent a more general paradigm shift in medical academia which is gradually moving away from postdoctoral training. The National Science Foundation (NSF) reports that the number of postdoctoral trainees within the United States in the biological sciences declined from 34.2% to 30.2% from 2010 to 2015, and the number of clinical medicine postdoctoral researchers declined from 26.0% to 24.8% (Arbeit and Kang, 2017). Interestingly, the number of postdoctoral researchers in the social sciences has increased by nearly 50% in the same timeframe.

As the ranks of classically-trained anatomists retire and leave the workforce, they must be replaced with a new generation of anatomy educators – a generation with the proper training and career focus necessary to succeed as faculty and one that enjoys greater parity with their research-focused colleagues. As such, training programs ought to equip future anatomy instructors with the essential knowledge and skills to not only effectively teach their discipline using evidence-based instructional strategies, but to also produce the requisite scholarship for tenure and promotion (Irby and O’Sullivan, 2018). A potential approach to facilitate the development of these educator-scholars is an anatomy education postdoctoral fellowship. In particular, graduates with limited knowledge of educational research methods, a lack of formal

training in pedagogy, or who have limited teaching experience may benefit from a fellowship tailored to their needs. Because fear of exploitation was identified in this study as a weakness of an education-focused fellowship, utilization of the National Academy of Sciences' recommendations that postdoctoral positions have clearly defined (temporary) periods of service, clearly defined titles and roles, appropriate levels of compensation, and a multifocal mentoring component may help to mitigate exploitation (National Academy of Sciences et al., 2014). The importance of mentorship for postdoctoral fellows is highlighted in the literature, as well as op-ed articles by individuals who have completed postdoctoral training (Scaffidi and Berman, 2011; Levy, 2014). While a mentorship model for anatomy education postdoctoral training has yet to be established, the National Postdoctoral Association (NPA, 2017) provides numerous resources for mentors and postdocs to help foster the mentor-mentee relationship.

Graduates of doctoral-level programs that aim to produce anatomy educator-scholars could still benefit from a postdoctoral experience that is intentionally designed. Becoming an excellent educator is not simply the result of innate skill, but a developmental process in which individuals learn to take on numerous roles, including content expert, course organizer, curriculum planner and evaluator, as well as mentor and role model (Harden and Crosby, 2000). Even in an anatomy education-focused doctoral program, graduates may not yet have had the experience of juggling all roles simultaneously, particularly with a faculty-level course load. A postdoctoral experience designed for individuals looking to take on the role of a scholarly anatomy educator would be a prime opportunity to facilitate the development of skills extending beyond expertise in anatomical sciences and educational research methodologies. In the present era of competency-based healthcare curricula, anatomy faculty are asked to take part in professional development of students, teaching students nontraditional discipline-independent skills (NTDIS) such as

professionalism, leadership, interpersonal and communication skills (Evans and Pawlina, 2015). To do so effectively requires that faculty have these skills well-developed themselves and the knowledge of how to teach and assess these skills in students. Whether it be via a postdoctoral fellowship or continuing professional development opportunity, development of longitudinal programs that focus on facets of faculty members' roles beyond teaching, including curriculum design, leadership, and other NTDIS are important for faculty success (Steinert et al., 2016). Providing such opportunities serves to protect institutional investments in new faculty by promoting individual, departmental, and institutional growth to achieve institutional goals that frequently emphasize quality teaching and learning outcomes (McLean et al., 2008).

Limitations

This survey- and interview-based research is not without limitations. Firstly, it is understood that researcher bias is present in thematic analyses of qualitative data. However, the use of two independent researchers and multiple readings of the responses is designed to lessen the effect of observer bias and enhance reliability of the analysis (Mays and Pope, 1995). Secondly, although efforts were made to ensure interviewees were representative of the initial survey participants, it is possible that the small sample size did not enable the perceptions of anatomy educators at-large to be fully captured. Thirdly, each survey was designed to measure factual information (versus a latent construct), mostly collecting nominal data. Because of the scarcity of ordinal items and no Likert-scale items, Cronbach's alpha and Kendall's tau-b cannot be computed.

Future Directions

While the survey data from current anatomy educators presented herein indicates an interest in anatomy education postdoctoral fellowships, the substantive contributions of such programs in developing anatomy faculty and enriching the field remain in question. A future study objective, therefore, is to assess the perceived influence of anatomy-education postdoctoral fellowships by evaluating perceptions amongst department chairs and faculty search committees to determine if a postdoctoral fellowship experience increases the likelihood of an applicant being invited for an interview. Additionally, because new graduates seem to have relatively little difficulty securing full-time faculty positions without a postdoctoral experience, assessing the interest of soon-to-be graduates would provide insight into the types graduate students who are most likely to pursue such an opportunity, if at all.

CONCLUSIONS

The findings presented in this study suggest that while most anatomy educators have graduate training in gross anatomy, many lack graduate coursework in other anatomical disciplines. Significant proportions of educators' graduate training are supplemented and expanded through formal mentorships, many of which occur on-the-job, and through postdoctoral training. While the number of individuals pursuing postdoctoral training appears to be declining, current anatomy educators agree that anatomy education postdoctoral training may be beneficial for new graduates to enhance educational and research-based skills and credentials. These data support further exploration into postgraduate training opportunities for future anatomists.

NOTES ON CONTRIBUTORS

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Table 1: Descriptive statistics of items included in the postdoctoral survey

Item Name	Item Description	N (%)
School classification	Classification of respondents' doctoral degree granting school	
	Non-US school	10 (15.6)
	Unclassified	1 (1.6)
	R1: Doctoral universities – Highest research activity ^a	47 (73.4)
	R2: Doctoral universities – Higher research activity ^a	4 (6.2)
Field	Specialty institution – Medical school and medical centers	2 (3.1)
	Field where doctorate was earned	
	Anatomy and/or Cell Biology	37 (57.8)
	Anthropology	13 (20.3)
	Education/Psychology	5 (7.8)
Rank	Physical Therapy/Movement Science	2 (3.1)
	Other	7 (10.9)
	Respondent rank	
	Instructor/Lecturer	8 (12.5)
	Assistant Professor	28 (43.8)
Tenure	Associate Professor	12 (18.8)
	Full Professor	14 (21.9)
	Other	2 (3.1)
Time in position	Respondent's academic track	
	Tenure	21 (32.8)
	Non-tenure	22 (34.4)
Completed postdoctoral training	Missing data	21 (32.8)
	Length of time in current position	
	Less than 6 months	4 (6.3)
	More than 6 months, less than 1 year	5 (7.8)
	1 to 2 years	12 (18.8)
Postdoctorate considered	3 to 4 years	14 (21.9)
	5 or more years	29 (45.3)
Postdoctoral training for graduates	Whether respondent completed postdoctoral training	
	No	35 (54.7)
Postdoctorate considered	Yes	29 (45.3)
	Whether respondent would have considered pursuing an anatomy education research postdoctorate if available	
Postdoctoral training for graduates	No	24 (37.5)
	Yes/Maybe	40 (62.5)
Postdoctoral training for graduates	Whether respondents consider an anatomy education research postdoctorate beneficial for recent doctoral graduates seeking careers as full-time faculty in anatomy.	
	No	9 (14.1)
	Yes/Maybe	55 (85.9)

^aThese institutions often have medical schools associated with them.

Table 2: Comparison of postdoctoral survey perceptions

Variable	Postdoctoral training considered P-value	Postdoctoral training for graduates P-value
School classification	0.380	0.065
Field	0.624	0.902
Rank	0.505	0.259
Tenure	0.109 ^a	0.518 ^a
Time in position	0.825	0.721
Completed postdoctoral training	0.424 ^a	0.342 ^a

Footnote: Refer to Table 1 for a description of each variable. Pearson Chi-Square Test or ^aFisher's Exact Test (significant at ≤ 0.05).

Table 3. Thematic analysis of qualitative data – advantages of an anatomy education postdoctoral fellowship.

Advantages

Main Theme	Developing research			Learning how to be a faculty member				Additional credibility
Subtheme	Learning new skills and techniques	Publication record	Establish independent project(s)	Time Management	Mentorship	Navigate Bureaucracy/Departmental Politics	Hidden responsibilities of the faculty	Mentorship to help increase rigor of educational research
Exemplar Quotes	“We get little or no experience in teaching, curriculum design and assessment, yet these skills are essential for success”	“I did complete a postdoctoral position focused on teaching and educational research. It helped to build my confidence in my ability to lead educational research projects. I also had multiple papers in the works, which allowed me to publish in my first years as a faculty member.”	“The same reasons research post docs are valuable- to learn new skills, gain experience, develop materials & get a start on publications”	“There is never enough time... a lot of juggling [is the only way to succeed]”	“I hope postdocs can allow someone to begin and develop a research line, get some publications written, do some experiments, having someone to guide you and not just throw you in the fire.”	“Every place has different values and unwritten rules, identifying those are hard and navigating the culture of a new place is a big challenge.”	“There are a new set of stresses, a new set of difficulties, a new set of responsibilities, and just having "PhD" behind your name doesn't make you prepared to do your job.”	“...elevate the literature, as a field.” “it would lend credibility to the idea of ed...I think that a qualitative or mixed-methods postdoc would help the realm of educational research to become more accepted.”

Table 4. Thematic analysis of qualitative data – disadvantages of an anatomy education postdoctoral fellowship.

Disadvantages

Main Theme	Exploitation		Financial		Teaching and educational research undervalued	
Subthemes	Low paid teacher	Lack of promised research time	Expensive for departments	Loss of salary for participants	Wasting time on undervalued skills	Delaying start of a full faculty position
Exemplar Quotes	“...there could be a tendency to make a postdoc into a low-paid anatomy teacher”	“A lot of people in our field only want teachers, and the research is secondary.”	“Funding is hard... We don't know of how to fund a PhD in anatomy. Not sure what kind of funding model would be sustainable to offer a MedEd postdoc”	“...paid them [postdocs] a quarter of a faculty salary.”	“University tenure committees do not value teaching training.”	“Some institutions are less likely to see educational scholarship at the same level as benchtop, fundable research and institutions may be less likely to hire these types of post-docs, even though they may really be better off with these types of faculty.”

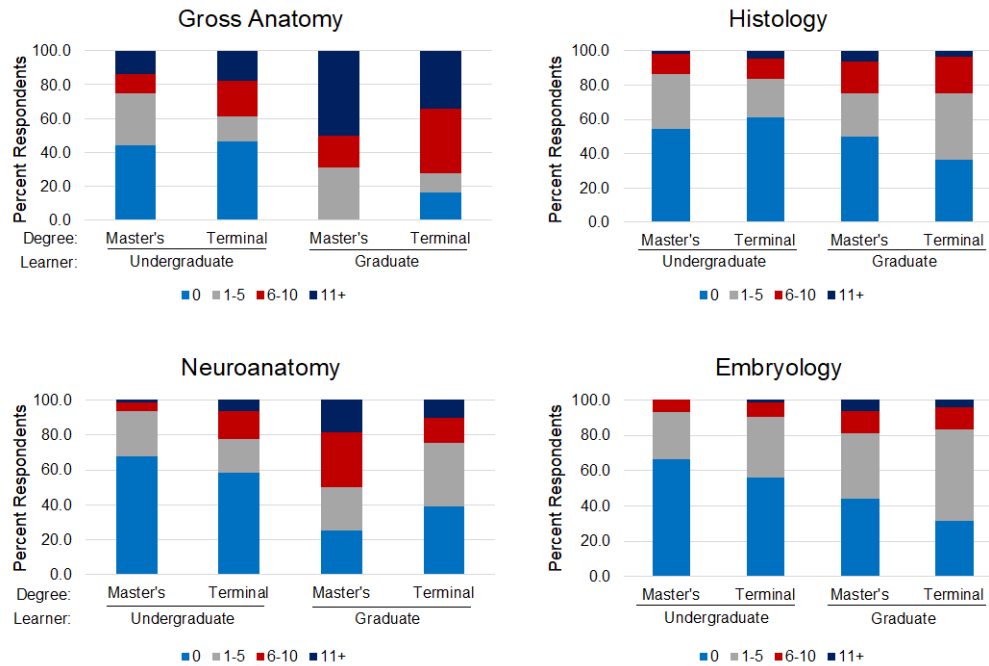


Figure 1: The percentage of anatomy educators having earned graduate credits in four anatomical science disciplines is plotted by learner group taught (undergraduate or graduate students) and highest degree held (master's or terminal degree). Graduate credit categories include zero credits, 1-5 credits, 6-10 credits, and greater than 11 credits.

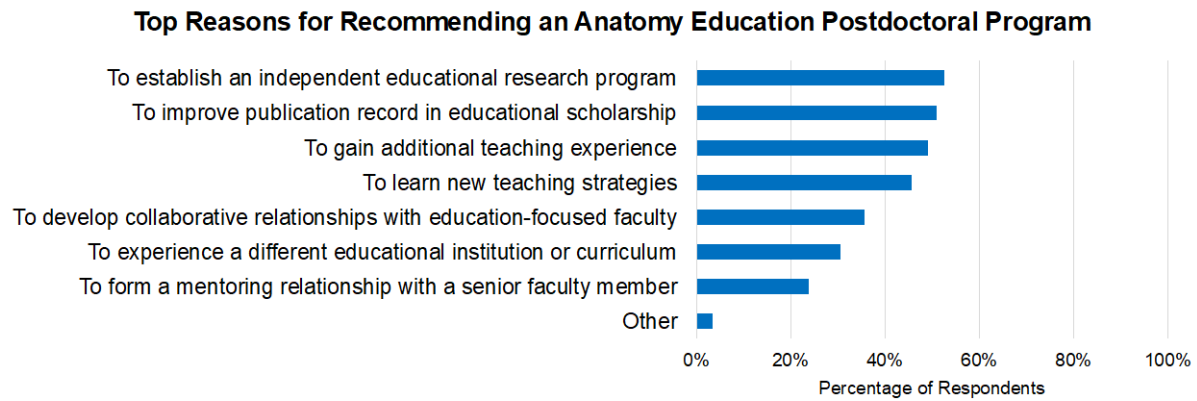


Figure 2: Reasons for recommending an anatomy education postdoctoral fellowship ordered by responses.