

Research Article

Promoting the Development of Core Competencies during Early Medical Education: Implementation of a Teaching Assistant Program in Anatomy Course

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Competency-based curricula that emphasize personal and professional development have been widely implemented in medical schools. To strengthen competency training during the early years of medical education, we established an anatomy Teaching Assistant (TA) program for raising second-year medical students. The medical student TAs assumed a leadership role in a dissection-based anatomy course for Physician Assistant (PA) students. They worked in the dissection laboratory demonstrating dissection techniques, confirming anatomic structures, and engaging PA students in dialog to facilitate a comprehensive understanding of anatomy. Two questionnaires were conducted at the end of the course: a "TA Self-Reflection Survey" completed by the medical students and a "TA Evaluation Survey" completed by the PA students. Both questionnaires addressed the development of TA core competencies during the course. The survey data indicated that medical student TAs acquired a greater base of knowledge for practice and enhanced interpersonal communication and life-long learning skills, such as the confidence to admit and correct mistakes. The data also indicated that the medical student TAs learned and demonstrated many attributes of professionalism, including commitment to excellence, respect and compassion for learners, timeliness, and inter-professional collaboration. The TAs agreed that they learned essential skills and behaviors that would benefit future patient care. Our findings indicate that anatomy TA programs provide a valuable opportunity for medical students to share basic science knowledge with allied health professionals and acquire a working knowledge of core competencies that are expected of practicing physicians.

Keywords: Competency; Medical education; Anatomy; Teaching assistant; Physician assistant program**Introduction**

Competency-based medical education for undergraduate and graduate training is widely accepted and has become the dominant curriculum model for medical schools in the United States [1] and around the world [2]. The Association of American Medical Colleges (AAMC) has developed guidelines for medical school curriculum development and identified specific core competencies for medical school graduates. Physician competency domains emphasized by the AAMC include: i) compassionate, appropriate and effective patient care; ii) knowledge for practice; iii) practice-based learning and improvement; iv) interpersonal and communication skills; v) professionalism; vi) system-based practice; vii) interprofessional collaboration; and viii) personal and professional development. Competency-based graduate medical education programs have also been developed in surgery [3], geriatrics [4], internal medicine and family medicine [5], pathology [6,7] and psychiatry [8]. Many of these graduate training programs have developed innovative curricula to help physicians acquire core medical competencies.

The "core entrustable professional activities for entering residency" established by the AAMC include technical skills and nontechnical competencies such as communication, teamwork,

decision-making and error management. Compared to technical skills, the nontechnical competencies are difficult to teach. Nonetheless, nontechnical competencies are of crucial importance for medical practice. Studies indicate that adverse events in health care are often caused by a failure in communication and/or teamwork [9-11]. Therefore, in response to the compelling need for improving physician's nontechnical skills, postgraduate residency programs in various disciplines have developed courses with an emphasis on nontechnical competency domains [12-16]. One approach, "multidisciplinary team simulation", has been described as a successful program for teaching both technical and nontechnical skills [17,18]. Unfortunately, literature reviews indicate that the level of evidence supporting the value of this approach is low and the impact of this type of training on patient care has not yet been objectively assessed [19]. Literature review also indicates that nontechnical skill training in surgical residency is marginally effective. The overall strength of the evidence concerning training outcome measures was graded as "moderate" in teamwork, "low" in patient-centered communication, decision making and coping with stress, and "very low" in patient safety and error management [20]. These findings emphasize the crucial importance of early nontechnical core competency training during medical education.

As preclinical science faculty and a medical student, we believe that the acquisition and strengthening of AAMC Core Competencies, especially the nontechnical competencies, should be a continuous process. It should begin during the early years of medical education in order to facilitate a smooth transition to competency-based clinical training and medical practice. However, there are virtually no reports on how medical educators can help medical students gain physician competencies during the early years of medical training, particularly in complex domains such as interpersonal communication skills, professionalism, and life-long learning skills. These competencies are difficult to teach using traditional methods of instruction, such as lectures, case studies and assigned reading. Objective methods for assessing medical competencies related to personal and professional development are often lacking.

To explore methods for strengthening medical students' competency training during preclinical undergraduate medical education, we established an anatomy Teaching Assistant (TA) program for rising second year medical students. Medical students who have completed their first year of preclinical basic science education are recruited to help teach Physician Assistant (PA) students in a Human Anatomy course. Medical students assume a leadership role in the course. They work alongside the faculty and assist PA students in cadaveric dissection. The medical students are encouraged to engage in scholarship by creating innovative teaching resources. Through these activities, the anatomy TA program provides medical students with a rich opportunity to gain an independent and professional identity. Here, we describe the implementation of this TA program, and document its effectiveness in helping medical students gain competencies expected of practicing physicians.

Methods

Anatomy course for Physician Assistant (PA) students

The Department of Pathology, Anatomy and Cell Biology, Thomas Jefferson University offers a dissection-based course in human anatomy to a combined class of students from Jefferson College of Health Professions (about 40 students) and Arcadia University (about 110 students). The course spans eight weeks over the summer and consists of 42 hours of lecture and 92 hours of cadaver dissection. The course is divided into three blocks: (1) back, upper limb and thorax; (2) abdomen, pelvis and lower limb; and (3) head and neck. At the end of each block, multiple-choice written and practical examinations are administered to evaluate students' understanding of theoretical concepts and dissected structures. PA students are required to pass both lecture and laboratory components of the course.

Instructors

Instructors for the PA anatomy course are faculty in the Department of Pathology, Anatomy and Cell Biology. The Department plays a major role in the undergraduate medical education at Thomas Jefferson University, providing 70% of the contact hours in the preclinical medical curriculum. Department faculty members teach gross anatomy, microscopic anatomy, neuroscience and pathology [20]. The Department also provides educational instruction to graduate students enrolled in various allied health professional training programs, including Physician Assistant, Physical Therapy

and Nursing.

Medical students recruited as Teaching Assistants (TAs)

During the past two years (2015 and 2016), a total of 16 rising second year medical students were recruited to serve as anatomy TAs. The medical students had recently completed several preclinical courses, namely human anatomy, microscopic anatomy, biochemistry, physiology, and neuroscience. To qualify for a TA position, medical students were required to have successfully completed these basic science courses. Medical students volunteered for the TA program, although some of the students were participating in a work-study program and were paid for their time and effort. The faculty interviewed all students who applied for the anatomy TA program. The course director provided a half-day training session to the TAs that highlighted the importance of adequate preparation for teaching and the need for professional interactions with the PA students.

Teaching assistant responsibilities

TAs are required to assist PA students in the cadaver-based dissection laboratories. They are expected to prepare for teaching by reading the dissection manual, reviewing online resources, consulting textbooks, examining prosected specimens, and consulting faculty members for additional information. Specific responsibilities include:

- Teaching. TAs are expected to demonstrate dissection techniques, confirm anatomic structures, answer questions, and engage PA students in a Socratic dialog to facilitate comprehensive understanding of anatomy.
- Assessments. TAs are expected to develop and administer practice examinations in the cadaver lab to help PA students become familiar with the practical testing format (e.g., identify the structure within the loop of red string).
- Tutoring. TAs are encouraged to help to PA students who are experiencing academic difficulty. TAs should convey tips and study strategies outside of class, based on their own learning experiences.
- Instructional tools. Scholarship activities are encouraged. One of the TAs produced an excellent teaching video that was posted online for the benefit of the entire class.
- Advanced dissection. TAs are expected to participate in self-directed advanced dissections that are demonstrated to the class. Over the past two years, TAs completed a laminectomy, as well as prosections of the lower limb, upper limb, cervical region, and head. These specimens are used to enhance understanding of challenging anatomical structures/regions, and facilitate PA student dissection.

Surveys administered to TA and PA students

Upon completion of the PA Human Anatomy course (2015 and 2016), a "TA Self-Reflection Survey" was used to collect data regarding medical student TA experiences in the program. The post-program questionnaire was designed to solicit feedback and assess the influence of the program on medical student professional growth. The questions were grouped to assess development of the following core competencies, namely i) professionalism, ii) interpersonal communication skills, iii) lifelong learning, and iv) medical knowledge

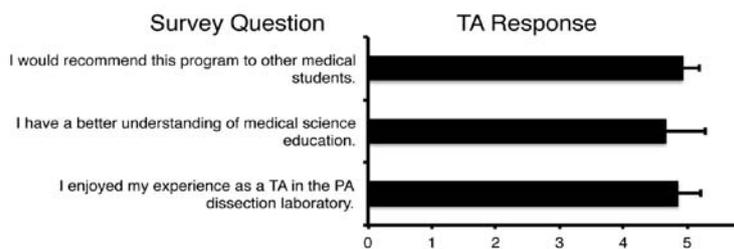


Figure 1: TAs' overall evaluation of the anatomy TA program. Black bars represent the mean Likert score and standard deviation.

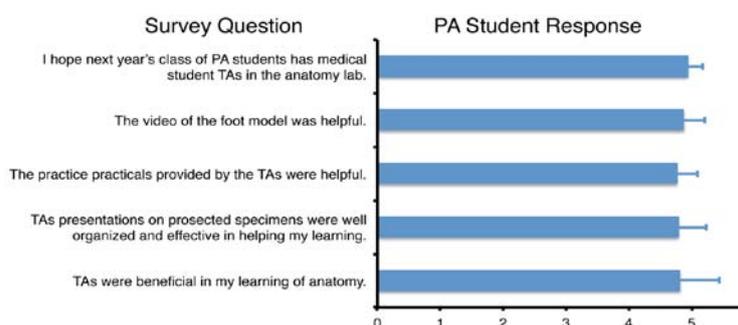


Figure 2: PA students' overall evaluation of the anatomy TA program. Blue bars represent the mean Likert score and standard deviation.

(Supplement 1: TA Self-Reflection Questionnaire). TAs indicated the extent to which the summer program enhanced their growth in these areas using a 5-point Likert opinion scale (strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree).

A separate "TA Evaluation Survey" was administrated to PA students at the end of the course in 2016. These survey questions were designed to assess PA student opinions regarding the TA's interpersonal communication skills, teaching effectiveness, anatomical knowledge, and overall professionalism. The questions used a 5-point Likert opinion scale (Supplement 2: TA Evaluation Survey). PA students were also asked to reflect anonymously, in writing, on their personal experiences with the medical student TAs. Data were analyzed using Microsoft Office Excel 97-2004 workbook (Microsoft Corp., Redmond, WA). The five-point Likert scale survey responses were converted into numerical scores ranging from 1 (strongly disagree) to 5 (strongly agree). Mean Likert scores and standard deviations were calculated and represented graphically as bars in the figures.

Results

Medical students valued their role as summer teaching assistants

Fifteen of sixteen TAs responded to the "TA Self-Reflection Survey". All of the responders reported that they valued the anatomy TA program (Figure 1); 73% strongly agreed and 20% agreed that they gained a better understanding of medical science education through participation in the summer program; 87% strongly agreed and 13% agreed that they enjoyed their experience as a TA in the dissection laboratory. All TAs answered affirmatively that they would recommend this summer program to other medical students. Medical student comments highlight the value of this teaching program:

"I enhanced my own knowledge of anatomy and feel that

I made a difference especially for a few students I worked with. It was a very rewarding experience both professionally, personally and academically".

"The teaching skills that were improved through the program include creativity, problem-solving, integrity, patience, articulation, and teamwork".

PA students appreciated contributions of TAs in the dissection lab

Seventy six (76) percent of the PA students from Jefferson and Arcadia completed the "TA Evaluation Survey" in 2016 (111 of 146 students). The PA students highly valued the contributions of TAs in the course (Figure 2); 97% of the PA students who completed the survey indicated that TAs were beneficial in their learning of anatomy; 98% either strongly agreed or agreed that the TAs' presentations on prosected specimens were well organized and effective; 95% indicated that the practice practical examinations provided by the TAs were helpful; 85% of the PA students responding thought that the video of the foot model was helpful. All of the PA students surveyed hoped that next year's PA class would have medical student TAs in the dissection laboratory.

Practice examinations provided by the TAs were informational and stress reducing

The medical student TAs designed and administered practice tests prior to each laboratory practical examination without faculty input. They adopted the same testing format for these tests that they experienced in their own medical school anatomy course. These "practicals" included questions based on prosected specimens, osseous structures and diagnostic images. PA students appreciated this effort, because the practice examinations provided examples of a new testing format, reduced test anxiety, and accurately demonstrated important learning objectives.

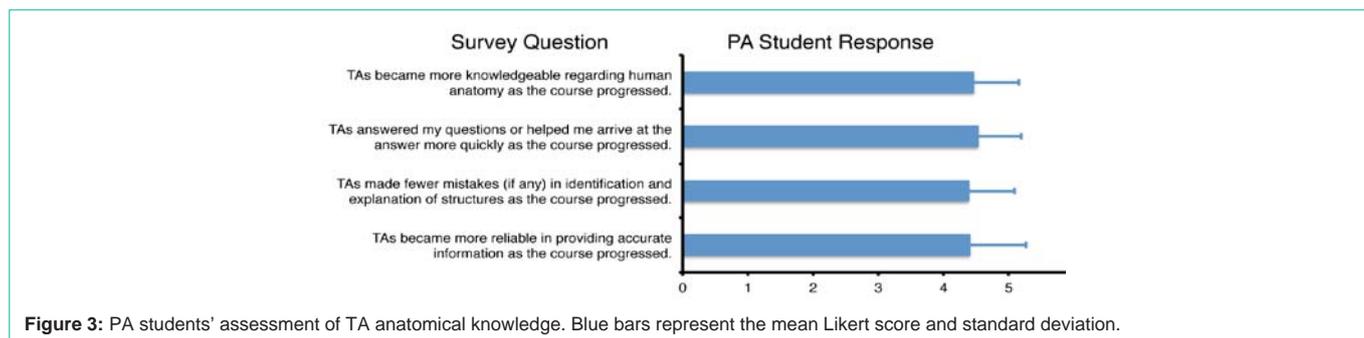


Figure 3: PA students' assessment of TA anatomical knowledge. Blue bars represent the mean Likert score and standard deviation.

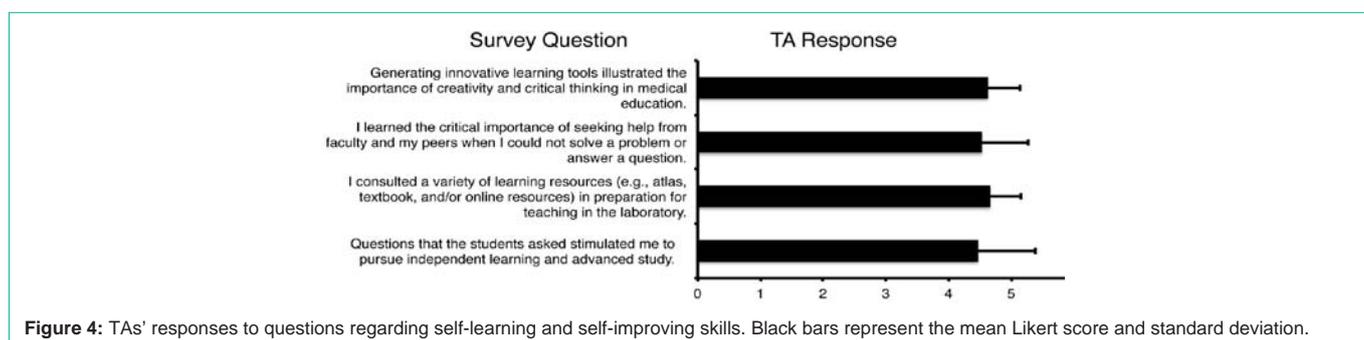


Figure 4: TAs' responses to questions regarding self-learning and self-improving skills. Black bars represent the mean Likert score and standard deviation.

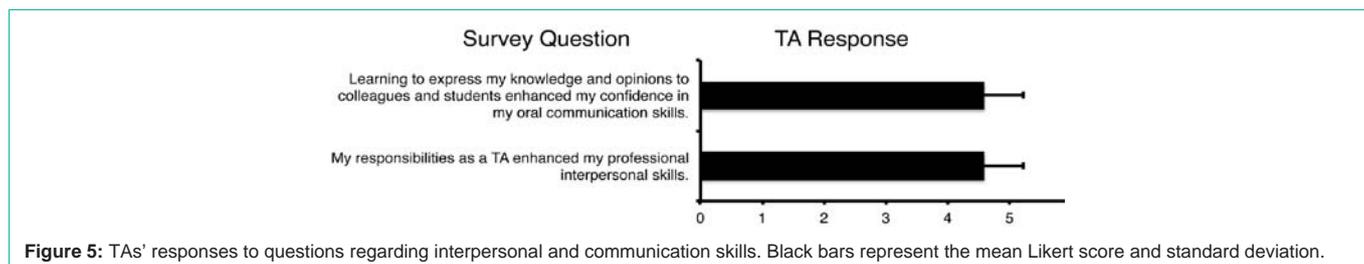


Figure 5: TAs' responses to questions regarding interpersonal and communication skills. Black bars represent the mean Likert score and standard deviation.

Teaching enhanced medical student TAs' knowledge of anatomy

Teaching at a level of detail and breadth similar to their own anatomy course required the medical students to recall, relearn, and integrate information into a functional framework. Considering their limited exposure to human anatomy in medical school, it is understandable that TAs would occasionally make mistakes in structure identification. However, we hypothesized that immersion in the summer teaching program would significantly improve medical student TA understanding of basic anatomy. Our survey data confirmed this hypothesis: all of the TAs (87% strongly agree and 13% agree) stated that their knowledge of human anatomy was strengthened through participation in the TA program (data not shown). The TAs provided the following thoughtful written comment: "not only was it (the TA program) a wonderful way to review anatomy, I was also able to integrate all of the knowledge that I learned throughout the year with a new appreciation for the human form".

Survey data provided by the PA students allowed us to objectively evaluate the growth of TAs' anatomical knowledge during the program (Figure 3). Most PA students (85%) either strongly agreed or agreed that the TAs became more reliable in providing accurate information as the anatomy course progressed; 87% answered affirmatively that

the TAs made fewer mistakes in identification and explanation of structures as the course progressed; 91% acknowledged that the TAs answered their questions (or helped them arrive at the answers) more quickly as the course progressed; 89% thought the TAs became more knowledgeable regarding anatomy as the course progressed. Some PA students indicated that the TAs were "always helpful and knowledgeable from the first to the last day". As expected, a few PA students mentioned that the TAs "gave wrong information especially in the beginning", but added: "this seemed to have gotten better towards the end of the course". Thus, the TAs' subjective reflections and the PA students' objective evaluations both indicated that medical student TAs' knowledge of human anatomy was enhanced by participation in the TA program.

Teaching promoted the development of self-improvement and life-long learning skills

The faculty challenged the TAs to prepare for each laboratory session in order to provide effective assistance, make fewer mistakes, and accurately answer questions. We hypothesized that these high expectations would serve to focus the TAs' attention on personal limitations in knowledge and skills, and serve to motivate them to acquire self-improving skills through self-directed learning and engagement in help-seeking behaviors. As shown in (Figure 4), all of the TAs indicated that they consulted a variety of learning

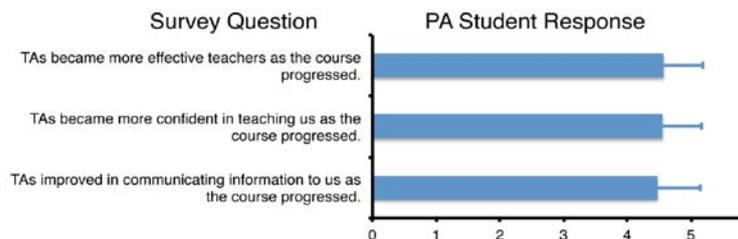


Figure 6: PA students' responses to questions regarding TAs' interpersonal and communication skills. Blue bars represent the mean Likert score and standard deviation.

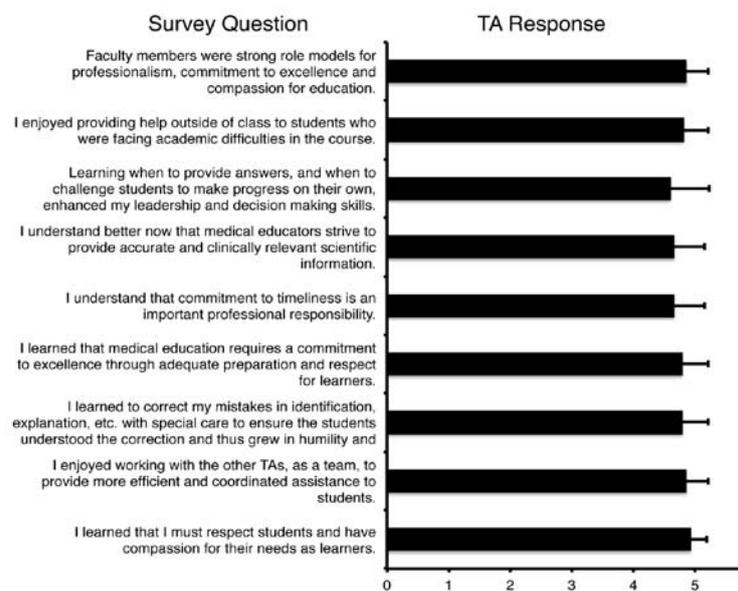


Figure 7: TAs' responses to questions regarding professionalism and altruism. Black bars represent the mean Likert score and standard deviation.

resources prior to class (e.g., textbook, atlas, and online resources) in preparation for teaching. Some TAs watched lectures and lecture recordings provided to them previously during their own anatomy course. One TA wrote, "...this was very helpful because it went into more detail than the PA students needed to know so I was able to use the extra information to supplement my teaching". Of the TAs, 87% realized the critical importance of seeking help from faculty and peers when faced with challenges, and 87% acknowledged that PA students' questions stimulated them to pursue independent learning and advanced study. For example, one of the TAs developed a short video to enhance understanding of the anatomy of the foot, and 89% of the TAs indicated that generating innovative learning tools promotes personal creativity and critical thinking.

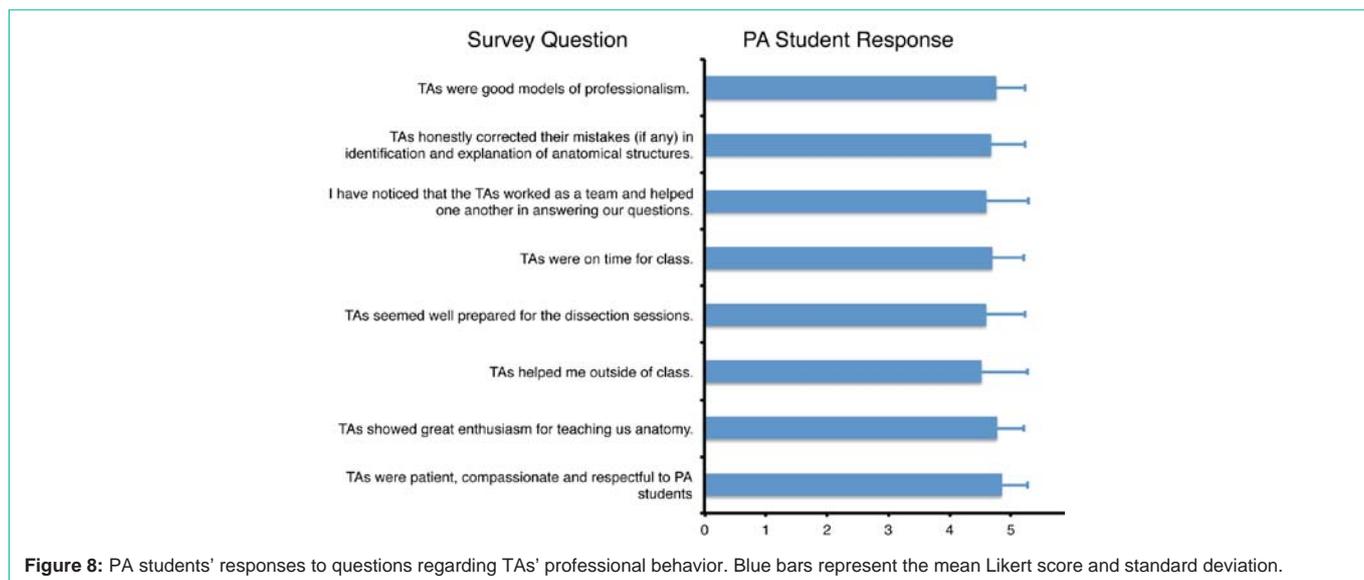
PA students had noticed the TAs' level of preparation for teaching: 95% of the PA students acknowledged that the TAs seemed well prepared for the dissection sessions; 96% noted that the TAs used multiple resources in the lab including anatomy atlases, circulating faculty members, and other TAs (data not shown). Together, the results indicate that participation in the anatomy TA program helped medical students enhance their lifelong learning skills, including the ability to consult multiple learning resources, initiate advanced study, seek help from peers, and create new learning resources.

Teaching strengthened medical student interpersonal and

communication skills

The TAs were expected to build rapport with the PA students and engage PA students in conversations to enhance learning (Socratic teaching) and to communicate with the faculty and peers to coordinate and improve teaching effectiveness. They were also asked to provide oral presentations of prosected specimens (e.g., laminectomy, as well as dissections of the head, neck, and extremities). As the TAs assumed a leadership role in the course we hypothesized that their interpersonal communication skills would improve. The survey data showed that 94% of the TAs either strongly agreed or agreed that participation in the TA program enhanced their interpersonal skills. For example, teaching helped them learn to express their knowledge and opinions to colleagues and learners, and enhanced their confidence in giving oral presentations (Figure 5).

PA students noted an improvement in the TAs communication skills (Figure 6): 90% of the PA students either strongly agreed or agreed that the TAs improved in communicating information to them as the course progressed; 93% responded affirmatively that the TAs became more effective teachers and more confident in teaching as the course progressed. In addition, PA students' written comments praised the TAs' presentation of prosected specimens as "well organized" and "professional". Thus, the survey data and the written notes from both TA and PA students indicated that the TAs'



communication skills were strengthened through the anatomy TA program. These interpersonal and communication skills are core competencies that are essential to their future career.

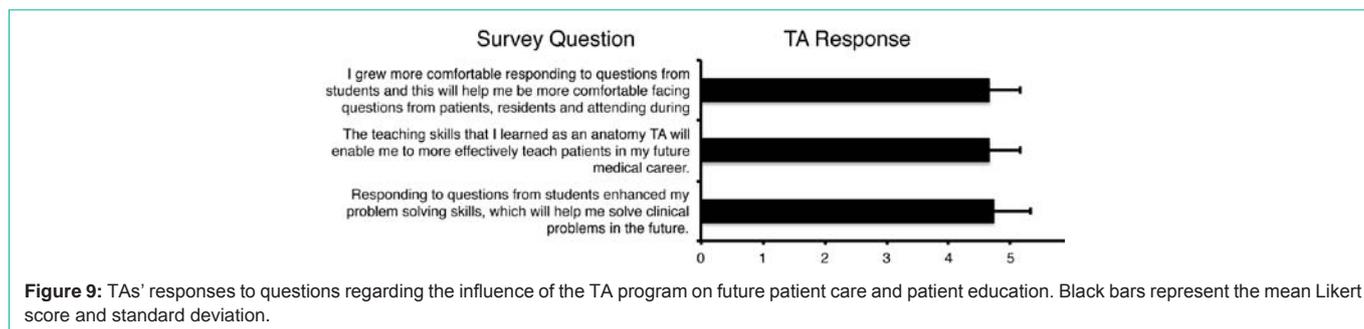
Medical student TAs learned key attributes of professionalism

The questionnaire administered to the TAs solicited information regarding many aspects of professional behavior, including commitment to excellence, desire to provide accurate and clinically relevant information, respect and compassion for students, teamwork and timeliness, strength to admit uncertainty/mistakes, and development of leadership skills. The TAs responded affirmatively to most of these questions and acknowledged that many enduring aspects of professionalism were strengthened through participation in the program (Figure 7). Medical student TAs valued highly “respect and compassion for learner”: 93% strongly agreed and 7% agreed that they must respect students and have compassion for their needs as learners. These data indicate that the student TAs were empathetic towards the PA students. All of the TAs provided help outside of class to PA students who were facing difficulties in the course and they enjoyed this experience. Teamwork was also highly regarded by the TAs: 87% strongly agreed and 13% agreed that they enjoyed working with peers as a team to provide more efficient and coordinated help to PA students. 80% strongly agreed and 20% agreed that they learned to correct mistakes and admit uncertainty, and thus grew in humility and integrity. One TA wrote, “It (teaching) showed me that sometimes it’s better to say ‘I don’t know’ than to make an assumption”. They also confirmed that medical education requires commitment to excellence through adequate preparation. Nearly all of the TAs (94%) acknowledged that their leadership and decision making skills were enhanced through the program, since they needed to learn when to provide answers and when to challenge students to make progress on their own. The TAs believed the anatomy faculty instructors were excellent role models for professionalism, exhibiting compassion for learners and commitment to excellence. These data suggest that professional behavior modeled by the faculty can positively influence the development of professionalism by the medical student TAs.

PA students' responses supported TA perspectives regarding professional development through participation in the program (Figure 8). Indeed, 96% of the PA students believed that the TAs were patient, compassionate and respectful, and 98% thought the TAs showed great enthusiasm for teaching. Most (88%) of the PA students confirmed that the TAs helped them outside of class. The PA students' notes expressed appreciation for the TAs' compassion and empathy. They appreciated that many TAs stayed late in the lab, helped them in the library, assisted them in small group learning, and sent them learning materials and resources. Regarding teamwork, 92% of the PA students have noted that the TAs worked as a team and helped one another in answering questions; 97% indicated that the TAs were on time for class; and 97% either strongly agreed or agreed that the TAs honestly corrected their mistakes (if any) in identification and explanation of anatomical structures. PA students appreciated the TAs' honesty regarding their limitations of knowledge or uncertainty. The PA students' comments indicate that honestly admitting to mistakes and uncertainty is important in all professional interactions, and contributes to the establishment of trusting relationships between medical professionals. Overall, 97% of the PA students regarded the TAs as good models of professionalism.

Teaching helped build core competencies related to patient care

Teaching in the dissection laboratory helped the medical student TAs acquire skills related to patient care, including problem-solving, decision-making, and leadership. Communication skills that the TAs gained through this summer program will enable them to provide more effective consultation, recommendations and explanations to their patients in their future careers. As shown in Figure 9, 93% of the medical student TAs surveyed indicated that their problem solving and teaching skills were enhanced through participation in the summer program. They all agreed that the skills they gained through teaching in the anatomy laboratory would enable them to more effectively teach patients and solve clinical problems in the future. All of the TAs answered affirmatively that they grew more comfortable responding to questions from students and this will help them to be more comfortable facing questions from patients, residents and



attending physicians during clinical training. One medical student TA summarized these thoughts, “both our understanding of anatomy and the variety of teaching skills that we built up will be appreciated by our future patients, colleagues and students”.

Medical student teaching promoted interprofessional collaboration

Close interactions between the medical student TAs and PA students during the course helped both groups develop mutual understanding and respect. These relationships will facilitate effective interprofessional communication and collaboration. Throughout the course, medical student TAs and PA students established connections in the dissection lab, small group setting, teaching/learning outside of class, and *via* social media (e.g., Facebook). Some PA students wrote “They (the medical student TAs) made connection, which was extremely helpful in making relationships”. Similarly, medical student TAs appreciated the opportunity to interact with PA students; “It was an empowering experience to be able to lead others through a challenging course, allowing me to demonstrate my knowledge and expanding my prior experience working in a team with future allied health professionals”. Thus, the TA program provided an opportunity for medical students and PA students to develop an interprofessional collaboration.

Discussion

The Teaching Assistant program at Sidney Kimmel Medical College provides an opportunity for medical students to gain crucial competency training during early medical education. Rising second year medical students that volunteer for this program assume a leadership role in a summer physician assistant anatomy course and work with the faculty as instructors. They share their knowledge of human anatomy with allied health professionals, and through this activity they gain skills and behaviors (competencies) that are expected of practicing physicians.

One of the keys to the success of our anatomy TA program is that the medical students are able to interact with allied health professionals (PA students) in an open, interdisciplinary learning environment. Opportunities for close interaction between different groups of students in the health professions are invaluable, because they model relationships that will continue in clinical practice. Early exposure to this collaborative working relationship enables medical students and allied health professionals to develop mutual understanding, respect, and cordiality. Another key feature of our anatomy TA program is the ability of medical students to collaborate with experienced teaching faculty. This interaction fosters the

development of leadership, professionalism, and communication skills. Previous study indicates that faculty mentors are widely recognized as crucial role models for medical competency training [21]. Medical students in our TA program shared this point of view. They believed that faculty were strong role models for professionalism. They were impressed with faculty’s commitment to excellence, empathy for student learners, and desire to provide accurate information. A third key to the success of our TA program is that it provides a unique opportunity for medical students to integrate knowledge and improve their understanding of human anatomy through teaching, and provides a valuable opportunity for medical students to learn from mistakes. This is an important life lesson that is not easily learned in a traditional classroom. If a TA did not know the answer to a question, he/she quickly learned that the best practice was to admit the lack of information. These encounters enabled medical students to realize the limits of their knowledge, and understand the need for lifelong learning.

Respect and compassion for learners and teamwork were rated by the medical students in the TA program as the two most important lessons learned from their experience as a teaching assistant.

Because the TAs had recently completed a course in human anatomy, they were able to empathize with the difficult work that was expected of PA students. The TA program provided an environment for the medical students to experience the needs of others, and thus enable them to demonstrate compassion, empathy, and respect for others. These are crucial attributes of practicing physicians. Teamwork is another skill that the TAs learned and rated highly. Challenged by students’ questions and facing difficulties at times in providing accurate information, the medical student TAs quickly learned the virtues of seeking help from peers (fellow TAs and faculty members). We believe that medical student teaching during early training can have a profound influence on the acquisition of skills and behaviors related to compassion and teamwork, and contribute to more effective patient care in the future.

Teaching is a complex human activity that benefits both students and teachers. Individuals benefit from teaching by improving their understanding of the material they present [22] and several studies have reported the benefits of involving students as peer tutors [23]. Peer assisted learning is a common practice in medical schools [24,25], either as an informal activity or a formal component of a course [26]. At our institution, peer teaching provides an opportunity for students assigned to one cadaver table to present the results of their dissection to another group of students in the same course. Erie et al. [27] reported that medical students participating in an anatomy-based student-

as-teacher program achieved teaching proficiency, and felt prepared for the teaching responsibilities associated with residency. Personal reflections of student TAs participating in a surgical anatomy course at Mayo Clinic College of Medicine indicated that participating in the TA program helped prepare them for upcoming training as surgical residents [28]. One crucial difference between our formal TA program and other peer teaching programs is that our medical student TAs are expected to assume a leadership role in the course. The TAs in our program are viewed as instructors - not peers. We believe that this elevated role motivates medical students to pursue strategies for self-improvement in knowledge and professionalism, and advocate for their own identity as leaders. Indeed, our results indicate that participation in the TA program developed at Sidney Kimmel Medical College promotes the development of many of the “core entrustable professional activities for entering residency” established previously by the AAMC (Figure 9).

The sample size in our study is small due to limited availability of TA positions. However, data will be collected in the coming years to confirm the significance of our findings. We also plan to identify assessment tools that can be used to objectively measure nontechnical skills such as professionalism and interpersonal communication skills, so as to validate our hypothesis.

In summary, our teaching assistant program provides an opportunity for competency training during the early years of medical education. We believe that early competency training provides medical students with a strong foundation for continued personal growth, and facilitates a smooth transition to subsequent clinical training. We encourage other institutions to develop similar opportunities for health professionals to enhance learning and acquire medical competencies.

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