

What impact does anatomy education have on clinical practice?

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Authors:

Dr Claire France Smith and Dr Haydn Socrates Mathias

Institution:

Centre for Learning Anatomical Sciences, University of Southampton, UK

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Corresponding Author:

Dr C. F. Smith

Centre for Learning Anatomical Sciences

School of Medicine

University of Southampton

Level B South Academic Block

Southampton General Hospital

Tremona Road

Southampton

SO16 6YD

Tel: 02380795763 Fax: 02380795761

Email: c.f.smith@southampton.ac.uk

ABSTRACT

There is continuing debate regarding doctors' knowledge of anatomy as an appropriate preparation for professional practice. This exploratory case study examined alumni's experiences of learning anatomy. The aim was to inform curriculum development and to gain a better understanding of how anatomy knowledge is applied in practice. A total of 140 medical student alumni from the University of Southampton participated in this study (49% males, 51%female). Participants completed a Likert Scale questionnaire with free comment sections. Descriptive results found that: using cadaveric material was an effective way of learning anatomy; assessment was a major motivator; and around half forgot a lot of anatomy but that knowledge came back easily. Statistical analysis revealed associations between certain promotion and negative factors in learning. Links were also seen with current job role, revealing that those who responded to positive factors were involved in careers which involved a great deal of anatomy and vice versa. The process of learning anatomy is further understood. To facilitate learning anatomy should be taught throughout the curriculum and use human cadavers. Relating knowledge to practice requires transformation of knowledge and is best facilitated by the learning being situated in clinical contexts.

Key Words: Alumni, application of anatomy, anatomy education.

INTRODUCTION

Debate over the end product of medical education has highlighted whether doctors know sufficient anatomy for effective practice (Collins 2008; Collins 2009). There has also been concern over rising litigation as a result of a lack of anatomy knowledge (Ellis 2002). An individual may have the knowledge but may lack the ability to apply the knowledge effectively in practice. Junior doctors' knowledge of anatomy has been shown to be varied (Gupta et al. 2008). There have also been debates among academics and newly-qualified doctors who have questioned not the amount of anatomy taught but rather the appropriateness of teaching methods used (Stringer & Nicholson 2008; Fitzgerald et al. 2008; Fitzgerald et al. 2009; Patel 2009). A key point is that whilst such debate is very interesting it does not elucidate what factors in an individual's anatomy education result in good quality learning that can be competently applied to practice.

Research exploring undergraduate anatomy education has found that perceptions of anatomy influence the approach to learning adopted (deep, strategic or surface) and, in turn, examination success (Smith & Mathias 2007; Mansouri et al. 2006; Pandey 2005). It is only with some understanding of how students learn at undergraduate level that we can now explore the transition to postgraduate learning and the relationship between them.

Researching the relationship between anatomy education and professional practice is complex and challenging since individual experiences can vary so much and defining knowledge and its application in professional practice is not straightforward. In this paper we report on an aspect of a mainly qualitative study in one university of the experiences of alumni's anatomy education and how this has influenced individuals' professional practice.

The University of Southampton's first cohort of medical students graduated in 1976. Before 1988 anatomy was taught in regions in year 1. After 1988 anatomy was taught in systems to year 1 and 2 students. Teaching methods included lectures, dissection and prosection practicals, tutorials and, from 1996, supported by computer assisted learning packages.

MATERIALS AND METHODS

We developed an exploratory study to examine how alumni's anatomy education had influenced their professional practice. Our initial aim was to help inform the development of the curriculum and the teaching and learning methods used. We also wanted to gather evidence which might further illuminate theoretical ideas about how knowledge is developed and used in professional contexts. For the purpose of this study the term 'anatomy' was generically used to cover all elements of the anatomical sciences: gross anatomy, histology, embryology, etc.

This exploratory study took place at the University of Southampton. The study was granted ethics approval (05/Q1704/147).

A small pilot study was initially conducted. Five clinicians were invited to participate in a focus group to discuss their anatomy education. Analysis of the transcript identified four clusters for further exploration:

1. Alumni's perceptions and experiences of anatomy education
2. Feelings about anatomy at the time of graduation
3. Anatomy in their current job
4. Overall reflections and recommendations.

An online questionnaire was constructed and pilot tested. Each subsequently refined cluster contained a series of questions requiring a Likert scale response (1=Strongly Disagree, 2= Disagree, 3= Neither Agree nor Disagree, 4= Agree, 5= Strongly Agree) and some questions requiring an open-ended response. The final questionnaire can be seen in Table 1. The questionnaire was constructed in Question Mark Perception TM and located on a server to allow access by participants.

Upon qualification medical graduates may seek employment throughout the county and

worldwide. To make this exploratory study more manageable we restricted our focus to those who graduated from the University of Southampton Medical School and who were registered within Hampshire and Dorset. Potential participants were invited by email and post through the University alumni office. From a potential sample of 792, 153 alumni responded. Any incomplete questionnaires were discounted, leaving a final sample of 140 (response rate of 18% and representing 6.4% of all alumni from Southampton Medical School). The sample comprised 69 (49%) males and 71 (51%) females. Based on changes within the curriculum, the date of graduation was divided into two categories, (category 1, 1975-1992 graduation, n= 60, and category 2, 1993-2006 graduation, n=80). The respondents were from a range of settings (GP 20%, Anaesthetic 12%, Surgical 18%, Medical 41% and other 9%). This was very much a convenience sample and one from which we sought to identify provisional issues rather than draw generalisations about the population as a whole.

The data were extracted from the server and imported into the Statistical Package for the Social Sciences (SPSS). The answers to open-ended questions were imported into Microsoft Word Files. The questionnaire was subjected to a series of statistical tests to seek possible related clusters or associations by correlating each question to the other questions. Demographics such as the year of graduation and current job were examined in relation to the Likert responses to each question.

RESULTS

Descriptive results: We report on the salient features of the questionnaire responses.

Cluster 1, alumni's perceptions and experiences of their anatomy education.

A large number of alumni (63.3%) indicated that assessment acted as a major influence and motivator for learning anatomy and nearly half (47.5%) felt they were not given advice on how to learn anatomy. A substantial majority (77%) agreed that using human cadaveric dissections was an effective way of learning anatomy (Figure 1) and that this understanding was facilitated through exploring the specimen. Despite this, 54.6% of alumni claimed forgetting a lot of the anatomy they had learned. This may reflect the adoption of a strategic or surface approach to learning.

Cluster 2, alumni's feelings at the time of graduation.

The majority of alumni (68.3%) were concerned that there was still so much anatomy they did not know. However, despite their concern about their anatomy knowledge, the majority of alumni (77%) felt that they had learnt enough anatomy to practise competently (at the time of graduation) (Figure 2). It is possible that some alumni had difficulty in applying knowledge and this is reflected by 38.1% reporting that they found it difficult to relate the anatomy they had been taught to practice. The majority of alumni (56.9%) reported that if they did forget something it came back easily with a small amount of study, highlighting that if the foundations were there then the knowledge could be restructured and used.

Cluster 3, anatomy in their current job.

Alumni gave a mixed response to their ability to visualise dissections and diagrams when working on clinical areas. This possibly reflected the approach to learning or the level to which the students engaged in understanding the three-dimensional form. Around half (51%) reported that they used more than 70% of the anatomy they had been taught during the course of an average year of practice. This supports the importance and relevance of

anatomy in clinical practice. Alumni responded that their use of anatomy was most integrated with radiology.

Cluster 4, overall reflections and recommendations.

The majority (61.2%) had found their anatomy education invaluable and some felt that it had influenced their career. The open-ended questions were analysed on paper by forming categories from the responses to each question. These are detailed in Table 2. Alumni's experiences involved both promotional and detrimental factors which affected their learning and possibly influenced their future career. Similar to students' experiences, alumni found a positive change in motivation as the clinical context required re-learning and application of earlier material.

Statistical results:

To examine if there was a relationship between how an individual responded to one question compared to another, a Spearman's correlation coefficient was calculated. Significant associations ($r > 0.5$, $p < 0.05$) reflected that enjoyment was linked to promotional learning activities. For example, studying human cadaveric specimens was correlated to information being conveyed into understanding when exploring specimens with their hands. Alumni who responded by agreeing that they enjoyed anatomy were also able to visualise images. The correlations highlighted that alumni who responded to remembering doing well in anatomy examinations were associated with alumni who also responded finding it easy to relate anatomy to practice and felt that their anatomy education was invaluable to them.

The correlation analysis revealed that the responses of alumni who reported forgetting most of the anatomy they had learned were negatively associated with their response to feeling that anatomy was invaluable to them. Whilst not significant, medium associations were highlighted between possible negative factors in alumni's experience and being concerned there was still a lot of anatomy to know. They could not relate anatomy learning to practice easily, and struggled to form a three-dimensional map of the body and visualise dissections.

Details alumni forgot over time did not come back easily for them and they responded to not looking forward to learning more anatomy.

Using the groups established by year of graduation a Mann Whitney test was applied to explore if alumni's year of graduation was linked to their Likert scale responses. Three significant differences were found. Question 6 ("The structures and concepts which we were examined on clearly reflected the anatomy that I used as a House Officer/ F1") was responded to highly by group 1 or early graduates ($p=0.026$). Question 7 ("I saw clearly how anatomy would be part of clinical practice from the beginning") was responded to again more highly by group 1 or early graduates ($p=0.012$). Question 20 ("I felt confident that I could ask for help with my anatomy knowledge if I needed to") was responded highly to by group 2 or later alumni ($p=0.032$), reflecting they felt more able to ask for help. The early graduates would have had more time devoted to anatomy and this perhaps explains these responses.

To explore if there was any association between alumni's current job and how they responded to the Likert scale questions a Kruskal Wallis test was performed. The significant associations are represented in Table 3. Five broad occupational categories were created: Anaesthetic, General Practice, Surgical, Medical, and Other, including F1 and 2 posts. The results show that alumni who were working in surgical specialties agreed with the question statements more than any other discipline and reflected the promotional elements described earlier. This confirms that surgeons' use of anatomy was greater than for other specialities. Alumni who responded significantly to forgetting their anatomy were associated with the category of 'other'. In examining the job roles in the 'other' category 60% of alumni were working in areas not related to practice and 40% were in their foundation year of practice. In speculating a possible explanation for this finding, alumni working in areas not related to clinical practice may have been influenced by negative experiences in their anatomy education.

DISCUSSION

This study aimed to inform curriculum development, the teaching and learning methods used, and to gather evidence which might further illuminate theoretical ideas about how knowledge is developed and used in professional contexts. The authors acknowledge that the sample was limited to individuals within Hampshire and Dorset which is a limitation of the study. Medical graduates from Southampton broadly 50% enter General Practice and the others all specialities, the higher response rates from those within the 'medical category' may be explained by their more direct contact with students at the University teaching Hospitals. The percentage of graduates entering the various specialities from Southampton is similar to other UK medical schools and hence the sample may reflect other institutions.

Two key discussion points have emerged: the process of learning and relating knowledge to practice.

Process of learning:

The study has shown how anatomy learning goes through a process of initial learning, forgetting, restructuring and applying. This can simply be diagrammatically represented as in Figure 3. This shows the initial building blocks where propositional and functional knowledge are acquired.

Considerable research has focused on how anatomy is taught in the early years of the curriculum but little on the longitudinal nature of anatomical education. We can conclude that early teaching in years 1 and 2 is very important and serves as building blocks on which students begin to restore, restructure and apply this knowledge. The study established that many perceptions of anatomy formed at medical school remain at the time of graduation: for example, the majority of alumni (68.3%) were concerned that there was still so much anatomy they did not know. Our findings also support other studies; for example, Blyth and Insull reported that 33% of graduates had felt that their knowledge was inadequate (Blyth & Insull 2006). Whilst it is common for students and trainees to forget information previously learnt (around 19%) (Ward & Walker 2008), the majority of alumni found that this knowledge

is easily retrieved, highlighting that whilst this information may be perceived to be lost it is informing the knowledge application process, as shown by the peaks and troughs in [the ascending line in Figure 3](#). This highlights the need for students to understand that this is part of the process of learning and wherever possible the foundations should be learnt through a deep approach.

This study, along with others (e.g. Fitzgerald et al. 2009), supports the use of human cadavers and that understanding is facilitated by exploring specimens. This three-dimensional experience represents the first part of how an individual's knowledge is interpreted and this touch-mediated perception learning experience is an important building block for later on.

Relating knowledge to practice:

As students and trainees continue their education not all alumni found it easy to relate the anatomy they had been taught to practice. As individuals begin to relate their knowledge to practice they are using procedural and conditional knowledge which requires transformation and integration; the knowledge has to be made into meaningful and useful components. This highlights the need for anatomy to be taught in context and not just in the early years but throughout the curriculum as carried out at some Medical Schools (Evans & Watt 2005). It is interesting that alumni feel there is still a lot of anatomy to know yet they feel their knowledge is safe for practice.

This may show the adoption of illness scripts (Schmidt & Boshuizen 1993), where it is suggested that during undergraduate medical training, medical students acquire elaborate causal networks explaining the cause of a disease. However, as this knowledge is experienced in the clinical setting the networks become 'encapsulated' (Schmidt & Boshuizen 1993, Boshuizen & Schmidt 1992 and Schmidt & Rikers 2007). Encapsulation represents the simplifying of networks that can be easily accessed. [this is represented higher up on the ascending line in Figure 3.](#)

There is a transforming part that occurs within the knowledge application that in anatomy

and medicine involves the three-dimensional form. As the learning process develops anatomy knowledge becomes encapsulated: for example, quickly being able to diagnose an abnormality from a CT scan, rather than having to identify the anatomical landmarks and work through the structures and their relationships. As described by Wilson et al, teaching can facilitate knowledge transformation by highlighting clinical procedures alongside anatomy instruction (Wilson et al. 2009).

Relevance is also a key part of enabling students, undergraduate or postgraduate, to become engaged in the subject. This facilitates new knowledge to then be built in context, either formally through postgraduate training or through self-directed learning. Alumni would have liked to have had more anatomy exposure throughout the course, and as postgraduates, to anatomy in the form of short refreshers. Alumni suggested that to improve anatomy learning the relevance and context of the material should be studied. This could be achieved by increasing the amount of surface anatomy and radiology.

Conclusion:

There is no absolute summit for anatomy education. It is an individual journey and understanding the longitudinal nature of anatomy education leads to the study making the following recommendations:

At undergraduate level

1. Assessment needs to promote relevant learning, e.g. knowledge and application.
2. Students need to be supported in the process of learning anatomy, e.g. provided with information about how to learn anatomy.
3. Anatomy teaching from day one needs to highlight the clinical relevance. This should involve integrally the use of surface anatomy and radiology as reflected by the principles suggested by Eraut (Eraut 1994).
4. Anatomy should be taught throughout the curriculum, not just in years 1 and 2 as

supported by others (Stringer & Nicholson 2006; Fitzgerald et al. 2009; Evans & Watt 2005; Dawson et al. 2009).

5. Anatomy teaching should involve the use of human cadaveric material.

Postgraduate level

6. Revisiting anatomy and refresher courses should be available to all postgraduates.

The authors are in agreement with Fitzgerald 2009 and Patel 2009 in that those wishing to enter a speciality that contains a high amount of anatomy should receive additional appropriate teaching, which may be in the form of demonstratorships (Stevens & Firth 2008).

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LEGENDS

Figure 1. Graph representing alumni responses to Question 9.

Figure 2. Graph representing alumni responses to Question 16.

Figure 3. The process of Anatomy Learning and Application to Practice.

TABLES

Table 1. Questionnaire.

<ol style="list-style-type: none"> 1. I personally enjoyed my time studying anatomy 2. I preferred learning anatomy by having the structures demonstrated to me 3. I preferred learning anatomy by exploring it in my own way 4. We were given advice and instruction on the possible ways to learn anatomy 5. My motivation for learning anatomy was primarily driven by the examination structure 6. The structures and concepts which we were examined on clearly reflected the anatomy that I used as a House Officer 7. I saw clearly how anatomy would be part of clinical practice from the beginning 8. I applied my basic sciences knowledge of anatomy whilst learning it in the first 2 years of the course 9. Studying human cadaveric prosections was an effective way to learn anatomy 10. The dissecting room experience helped me deal with the issues of death 11. The dissecting room helped my learning of the language of medicine 12. The curriculum and teaching methods in anatomy suited my style of learning at the time 13. I forgot most of the anatomy I learnt in the first couple of years 14. I have a three dimensional map of the human body in my mind which I can visualise 15. From what I recall I did very well in anatomy examinations 16. I felt I had learnt enough anatomy to practise competently 17. I found it easy to relate the anatomy we had been taught to practice (e.g. why wrist drop is a sign of radial nerve damage) 18. I only began to realise anatomy's' relevance to clinical practice when I graduated. 19. I was concerned that there was still so much anatomy I did not know 20. I felt confident that I could ask for help with my anatomy knowledge if I needed to 21. I was looking forward to learning more anatomy in my future career 22. I found details that I could not remember came back quickly and easily with a small amount of study 23. In practice I do not see or think about anatomy as a separate subject 24. I find it easy to work though a clinical case and pick out the anatomy components 25. When working in a clinical area or whilst reading I can visualise some prosections that we worked on 26. I can visualise some anatomy drawings/diagrams that we used (e.g. the brachial plexus) 27. Please rate how often you use the anatomy you learnt at medical school in your current job role 28. Please indicate how much of anatomy from what you remember being taught you feel you use over a year 29. My anatomy education was invaluable to me 30. My knowledge and interest in anatomy influenced my chosen career path 31. I struggled learning the 3 dimensional aspect of anatomy 32. I found information was conveyed into understanding when exploring specimens with my hands <p>Free Comments section:</p> <p>If you had to re-learn anatomy or develop it further please state what for.</p> <p>How did you re-learn your anatomy?</p> <p>My use of anatomy is most integrated with my use of</p> <p>I found anatomy learning was most effective through.</p> <p>I would have liked to have worked as a demonstrator in anatomy because</p> <p>I find my anatomy knowledge is comparable to colleagues who studied at other medical schools</p> <p>What changes would you like to see in anatomy education?</p> <p>If you were not happy with your experience of anatomy please say why</p> <p>If you have contact with students or junior staff, how effective do you perceive anatomy education today to be?</p>

Table 2. Responses and Discussion of Free Comments

Question	Discussion
If you worked as a demonstrator in anatomy please explain a little bit of where, why and what you gained from it.	Eleven respondents stated that they had worked as a demonstrator. Their comments focused on the role of a demonstrator post being essential to pass surgical exams. It was perceived that many students forgot their initial anatomy training and they all needed to re-learn it to work towards an 'encyclopaedic knowledge' of anatomy for their surgical careers.
If you had to re-learn anatomy or develop it further please state what for.	Forty-eight responses focused around the postgraduate exams of the past and present. The remainder of responses (44) reported re-learning anatomy relevant to a procedure, case, Notably imaging also featured in that alumni reported understanding such imaging modalities as X-rays, CT and ultrasound. Many simply stated that they had forgotten their anatomy but that when they had revised it, it made sense.
How did you re-learn your anatomy?	Alumni's answers focused on textbooks or handbooks they used as a student, reflecting the small amount of learning resource technology that was available to many alumni when they were students. Postgraduate courses were a point of perceived learning, as was demonstrating.
My use of anatomy is most integrated with my use of:	Alumni predominately listed radiology first, and then physiology and then pathology illustrating how alumni felt anatomy knowledge was integrated in practice.
I would have liked to have worked as a demonstrator in anatomy because	The majority of answers stated they would not! Approximately 20% of participants responded saying that they did. If they would liked to have or did, alumni responded by saying that demonstrating would consolidate knowledge, with the belief that if you can teach you understand.
What changes would you like to see in anatomy education?	Alumni's comments focused on the wanting of a more functional, interactive and linked approaches to aspects such as radiology and surface anatomy. Some responded by requesting further anatomy 'refresher' courses and dissection. Several comments were made about wanting to try computer programmes, especially virtual reality ones.
If you were not happy with your experience of anatomy please say why	Some alumni (14%) reported not seeing anatomy early on in their training as being clinically relevant and hence this affected their motivation to learn. Approximately 10% of comments reflected alumni's personal experiences of finding the dissecting room environment distasteful, while others felt that not dissecting had hindered their learning. A lack of direction as to what alumni were supposed to be doing also featured (13%) with some alumni reporting that felt unable to ask for help.

Table 3. Significant associations between alumni's job role and their response to Likert scale questions

Question	<i>P</i> Value	Significant to category
1, I personally enjoyed my time studying anatomy	0.007	Surgical
9, Studying human cadaveric prosections was an effective way to learn anatomy	0.011	Surgical
10, The dissecting room experience helped me deal with the issues of death	0.021	Surgical
13, I forgot most of the anatomy I learnt in the first couple of years	0.027	Others
15, From what I recall I did very well in anatomy examinations	0.019	Surgical
21, I was looking forward to learning more anatomy in my future career	0.008	Surgical
24, I find it easy to work though a clinical case and pick out the anatomy components	0.010	Surgical
27, Please rate how often you use the anatomy you learnt at medical school in your current job role	0.000	Surgical
29, My anatomy education was invaluable to me	0.031	Surgical
30, My knowledge and interest in anatomy influenced my chosen career path	0.000	Surgical
32, I found information was conveyed into understanding when exploring specimens with my hands	0.022	Surgical