Journal of Anatomy

J. Anat. (2014) **224**, pp270–278 doi: 10.1111/joa.12089

The context of learning anatomy: does it make a difference?

Claire F. Smith,[1,4] Concepción Martinez-Álvarez[2] and Stephen McHanwell[3]

[1]*Brighton and Sussex Medical School, University of Sussex, Brighton, UK*
[2]*Departamento Anatomía y Embriología Humana I, Facultad de Medicina, Facultad de Odontología, Universidad Complutense de Madrid, Plaza Ramon y Cajal, Ciudad Universitaria, Madrid, Spain*
[3]*Oral Biology, Level 7, School of Dental Sciences and School of Medical Sciences Education Development Dental School, University of Newcastle upon Tyne, Newcastle, UK*
[4]*Centre for Learning Anatomical Sciences, Faculty of Medicine, University of Southampton, Southampton, UK*

Abstract

This study set out to ascertain whether the context in which anatomy is learnt made a difference to students' perceptions of learning. An Approach to Learning Inventory (ASSIST) and a 31-item Anatomy Learning Experience Questionnaire (ALE) were administered to 224 students (77 dental, 132 medical and 19 speech and language) as a multi-site study. Results revealed that 45% adopted a strategic, 39% a deep and 14% a surface approach. Trends between professions are similar for a deep or strategic approach (both ~ 40%). However, a surface approach differed between professions (7% dentistry, 16% medicine, 26% speech and language science). Dental students responded more to being able to use their knowledge than did other groups ($P = 0.0001$). Medical students found the dissecting environment an intimidating one and subsequently reported finding online resources helpful ($P = 0.015$ and $P = 0.003$, respectively). Speech and language science students reported that they experienced greater difficulties with learning anatomy; they reported finding the amount to learn daunting ($P = 0.007$), struggled to remember what they did last semester ($P = 0.032$) and were not confident in their knowledge base ($P = 0.0001$). All students responded strongly to the statement 'I feel that working with cadaveric material is an important part of becoming a doctor/dentist/health care professional'. A strong response to this statement was associated with students adopting a deep approach ($P = 0.0001$). This study has elucidated that local curriculum factors are important in creating an enabling learning environment. There are also a number of generic issues that can be identified as being inherent in the learning of anatomy as a discipline and are experienced across courses, different student groups and institutions.

Key words: anatomy education; approach to learning; teaching anatomy.

Introduction

One of the goals of higher education is to create an environment in which quality student learning can occur (Biggs & Tang, 2011). If effective learning is to occur, then the design of courses needs to be underpinned, either explicitly or implicitly, both by theories of student learning but also by the more practical theories of instructional learning and course design that seek to give practical guidance to the designing of courses (Moseley et al., 2005). The design, content and structure of anatomy courses have come under scrutiny from several directions in recent years. A number of studies have claimed to document a decline in the knowledge of anatomy acquired by students, recent graduates and newly qualified trainees. This decline in anatomical knowledge has been cited as one reason for increasing surgical errors and the consequent increases in medico-legal litigation (Ellis, 2002; Older, 2006). One reason for this decline in anatomical knowledge is likely to be a general reduction in the time available for anatomy teaching (and other biomedical science teaching) in medical curricula (Drake et al., 2002, 2009); a decline that is often a general feature of professional curricula in which anatomy is taught. This reduction in time is due to a combination of pressures; the sense from a number of quarters that anatomy has, in the past, been overtaught and the need to accommodate newer knowledge of various kinds into medical, dental and other professional curricula. Thus anatomy, in common with many other subjects in professional courses, finds itself caught

Correspondence
Dr Claire Smith, Head of Anatomy, Brighton and Sussex Medical School, Medical School Building, Biology Road, University of Sussex, Falmer, BN1 9PX. UK. E: c.smith@bsms.ac.uk

Accepted for publication *11 July 2013*
Article published online *12 August 2013*

between those who argue that too little and those who argue that too much is being taught. Whatever the merits of these debates it has clearly never been more important to ensure that the time available for teaching anatomy is effectively deployed and that an optimal learning environment is created, This requires that we understand better how students might approach learning anatomy so that we can in turn understand why students might be failing to understand and apply anatomy effectively. This will mean that it is necessary to draw on educational theory to investigate students' perceptions of learning and the approach to learning they adopt. In so doing we will be making an important transition from high quality teaching to high quality teaching underpinned by theory (Kreber, 2002).

Our understanding of how students learn has been critically shaped by the seminal work initially of Saljo and Marton (Saljo, 1979) and later of Marton and Pong (Marton & Pong, 2005) and Ramsden (Ramsden, 2003) through their investigations of how students tackled various learning tasks. These authors were able to identify qualitatively different approaches to learning characterized by the students' conceptions of learning, their perceptions of the learning context, the influence of their previous learning experiences, their intentions for learning, and their learning preferences. The main approaches to learning identified were conceptualized as 'surface learning' and 'deep learning'. Subsequent work led to the identification of a further distinct approach of 'strategic'' (or 'achieving') learning. A deep approach to learning is characterized by a motivation to understand the topic. In contrast, a surface approach to learning is characterized by rote learning and the simple regurgitation of facts. A strategic approach to learning is one that is focused on assessment, where students adopt whatever method of learning they perceive will achieve the best test results. In recent work, Hattie (2009) has suggested that a further approach to learning can be recognized, which he termed constructed understanding. Constructed understanding is defined as learning which builds upon surface and deep learning and is where the learner shapes their own ideas that allow them to identify general rules and make predictions based upon defensible theories.

Unlike learning styles which are preferences linked to psychometric variables, learning approaches are very much dependent upon the context in which learning takes place. Thus, learning approaches are not relatively fixed aspects of a students' personality; instead, a student may adopt a surface approach to one facet of their learning but a deep approach to another (Ramsden, 2003). It is crucial that we as teachers recognize and understand that the learning approaches students adopt are influenced by the things we do. It is also important to recognize that surface learning is not, in itself, a bad thing. Instead, a balance has to be sought, for if deep learning is to occur, this has to be preceded by some surface learning, thus both surface and deep learning are a necessary part of understanding (Hattie, 2009).

The reason for achieving an understanding of how students approach their learning is that this will influence course design. A number of models of instructional design have been proposed (reviewed in Moseley et al., 2005). One of the most influential models is by Bloom (Bloom et al., 1956) and to varying extents his work has influenced all subsequent work in this area. A model that has been especially influential in higher education is the Structure of the Observed Learning Outcome model (SOLO taxonomy) of Biggs and Collis (Biggs & Collis, 1982; Biggs, 1999). There are clear linkages between the levels of taxonomy proposed by Biggs and Collis and the conceptions of learning formulated by Saljo. Approaches to learning categorized as deep are associated with learning outcomes that map to higher levels of the SOLO taxonomy relating to understanding of a topic. If, as teachers, we seek to foster understanding then we must endeavour to ensure our students adopt progressively deeper learning approaches once they have mastered an introduction to the subject through the acquisition of requisite surface learning.

Various methods have been used to determine the approaches to learning that students are adopting. This has involved the use of both interviews and questionnaires. The two most commonly used questionnaires are those devised by Biggs and by Entwistle and colleagues. In this study we used the Approaches and Study Skills Inventory for Students (ASSIST) (Entwistle, 2006) to measure learning approaches.

Approaches to learning inventories alongside qualitative methods have been utilized to understand anatomy learning around the world (Pandey & Zimitat, 2007; Smith & Mathias, 2007a,b, 2009, 2010; Ward, 2011). These studies have all shown consistent findings illustrating that a deep approach enables high quality learning and application of knowledge. A weakness of these studies is that they are limited to one institution and single programmes. There has been very little work comparing the learning of anatomy by students preparing to work in different professions in which the need for anatomical knowledge and its applicability to professional practice will necessarily be very different.

The purpose of this study is to contribute to our understanding of how students learn anatomy by examining student learning of anatomical information in different professional disciplines and in different institutions to test the generalizability of any conclusions we reach.

Specifically this project aimed to:

(i) Further develop our current understanding of the approaches to learning adopted by students studying within medical, dental and speech and language science curricula.

(ii) Compare findings across other institutions and other disciplines within and outside of the UK to test the generalizability of the conclusions drawn by other studies.

Materials and methods

Study design

The study is a cross-sectional, comparative multi-site study. The study explored students' approaches to learning anatomy during a single academic year. The study involved three institutions and three different professions (Table 1). The study received ethical approval from all participating institutions (SOMSECsc0809.01).

Context

The three institutions involved in this study (Newcastle, Computense and Southampton) use similar anatomy teaching methodologies involving lectures, small group sessions and practicals to teach anatomy to students in their first 2 years of their programme. Students experience a similar number of taught time-tabled hours devoted to anatomy in each institution: dental students at Newcastle receive 100 h, dental students at Computense 130 h and medical students at Southampton 130 h. Speech and Language students receive a smaller number of hours (60 h) of anatomy teaching. All students have access to human cadaveric material through prosection and dissection, and a range of other resources including models and e-learning. Assessment is through a combination of integrated questions, objective testing and practical examinations.

Participants

All potential participants (n = 500; selected by their registration on a Bachelor of Medicine, Dentistry or Speech and Language Science Course in one of the three participating institutions) were invited by e-mail to participate in the study. Individuals who decided to participate (228, 45.6%) were provided with a Participant Information Sheet and, if they agreed to participate, were required to sign a consent form. Table 1 provides details of the sample. Due to the curriculum at Southampton spiralling through the early years it was appropriate to invite students from both year 1 and year 2 to participate.

Questionnaire

Two elements were brought together through one Likert-scale questionnaire. The elements were the ASSIST, 52-question inventory (Entwistle, 2006), which had been adapted with permission to insert the word 'anatomy' as appropriate, and an Anatomy Learning Experiences Questionnaire (ALE), a 31-question inventory designed to ascertain students' perceptions and experiences at their institution. Use of the ALE made it possible to relate the ASSIST inventory to the context of learning anatomy. The anatomy component (Anatomy Learning Experience Questionnaire, ALE), was divided into the following clusters:

(i) Cluster 1. The activities students prefer to do to learn anatomy
(ii) Cluster 2. Student experiences and feelings about working on cadavers
(iii) Cluster 3. The problems students encountered
(iv) Cluster 4. How students currently use their anatomy knowledge
(v) Cluster 5. Students' overall perceptions of anatomy

The anatomy component of the instrument had been previously validated and reported in Smith & Mathias (2007a,b, 2010, 2010). The questionnaire was distributed in paper format during the first semester and took students no more than 30 min to complete. Where required, the questions from ASSIST and ALE questionnaire elements were translated into Spanish. The ASSIST component has been widely used internationally but this is the first time the ALE has been used in Spain, so double back translation was used to check that original meanings within the content had been preserved.

The returned questionnaires were then optically scanned and the data entered into IBM SPSS™ version 19. For the purposes of subsequent data analysis results were considered significant if $P < 0.01$. Within the data, seven missing values were shown. The original paper versions were checked and no entry was found to have been missed by the optical scanning process, the student had simply not entered a value. So as to not lose all the rest of that individual's data, a 3, 'unsure', neutral value was inserted in these cases.

ASSIST scores were calculated as detailed in the ASSIST inventory instructions (Entwistle, 2006). In brief, each question is categorized as representing a deep, surface or strategic approach. The scores from the 52 questions were totalled. The highest scoring category is defined as the predominant approach. The dominant approach was given a nominal number (1 = deep, 2 = strategic, 3 = surface). In five cases, students had equal preference – this was denoted by a number 4. Results are expressed with significance set at $P \leq 0.01$.

Non-parametric tests were performed to ascertain differences between variables. To explore any relationship between approach to learning and the course of study, percentage comparisons were utilized (Table 2). To establish whether there was any relationship

Table 1 Participating institutions and sample details.

Institution	Course	Year of study	Number of participants	Gender	Gender% of course
University of Newcastle	Bachelor of Dental Sciences (BDS) (1)	Year 1	29	11M	M 50%
				18F	F 50%
	Bachelor of Speech and Language Science (2)	Year 1	19	4M	M 5%
				15F	F 95%
University of Complutense de Madrid	Bachelor of Dental Sciences (BDS) (3)	Year 1	48	13M	M 40%
				35F	F 60%
University of Southampton	Bachelor of Medicine 5 year Course (BM5) (4)	Year 1 and 2	65	47M	M 40%
			67	85F	F 60%
			Total 224		

Table 2 Approaches to learning and percentages relative to course.

Course (number for reference)	Frequency of deep approach to learning (%)	Frequency of strategic approach to learning (%)	Frequency of surface approach to learning (%)	No preference in approach to learning (%)
Dentistry (1)	12 (41)	13 (45)	2 (7)	2 (7)
Speech and Language Science (2)	7 (37)	7 (37)	5 (26)	0 (0)
Dentistry (3)	18 (38)	26 (54)	3 (6)	1 (2)
Medicine (4)	52 (39)	57 (43)	21 (16)	2 (2)

Table 3 Relationship between courses and responses to Anatomy Learning Experiences Questionnaire.

Question	Course significantly responding	Kruskal–Wallis *P*-value
5. I find/found mock exams an effective way of learning anatomy	Dentistry (1)	0.003
12. I feel that working with cadavers helped me to positively address the issue of death	Dentistry (1)	0.005
21. I feel the course allows me to quickly use my anatomy knowledge	Dentistry (1)	0.000
24. I find I am using anatomical terms and language at most clinical opportunities	Dentistry (1)	0.009
26. I find I use my surface anatomy knowledge frequently in clinical situations	Dentistry (1)	0.020
29. I feel that working with cadaveric material is an important part of becoming a doctor/dentist/health care professional	Dentistry (1)	0.009
1. I find/found reading textbooks an effective way of learning anatomy	Dentistry (3)	0.000
4. I find/found using imaging material (e.g. MRI) an effective way of learning anatomy	Dentistry (3)	0.000
25. I find I use my anatomy radiology knowledge frequently in clinical situations	Dentistry (3)	0.006
2. I find/found on-line material an effective way of learning anatomy	Medicine (4)	0.000
10. I feel the Dissecting Room is a daunting environment to learn in	Medicine (4)	0.006
14. I believe that the anatomy resources within the school are limited	Medicine (4)	0.000
16. I have problems learning anatomy because the teaching styles do not suit me	Medicine (4)	0.000
13. I find/found the amount of anatomy I need/ed to learn daunting	Speech (2)	0.000
18. My main motivation for learning anatomy is to pass exams	Speech (2)	0.007
20. I struggle to build on my anatomy knowledge as I often forget what I learnt last semester/year/s.	Speech (2)	0.005
22. I have problems using my anatomy knowledge because I am not confident in my knowledge base	Speech (2)	0.000
31. Because of the speciality I am interested in I feel anatomy is not important to me	Speech (2)	0.027

between how students responded to the ALE and their course of study, a Kruskal–Wallis test was performed (Table 3). To explore the interplay between approach to learning and how individuals responded to the ALE, a Kruskal–Wallis test was performed (Table 4). Finally, to see if gender exerted any effect on the responses to the ALE, a further Kruskal–Wallis test was performed (Table 5).

Focus groups

A series of seven structured focus groups were undertaken with students (n = 37). Due to translation costs these were only transcribed at the UK institutions. The focus groups were transcribed verbatim and subjected to nodal analysis by line by line coding. Phenomenographic bracketing (to suspend preconceptions) was used as appropriate to allow for theory generation (Marton & Pong, 2005). Each node was then brought into categories that emerged from the data from a grounded theory approach (Glaser & Strauss, 1999). These then formed the following main themes; stages of learning, approaches to learning, learning pathologies, assist to learning and institution specific issues.

Results

The response rate of the study (45.6%) might be considered low, but the researchers approached this study in a conformative manner. The study as a whole aims to contribute to our understanding of how students learn anatomy. We believe that this exists as real and relatively stable entities that can be explored in a rigorous manner. Therefore, a post-positivist stance has been adopted in this study, acknowledging that as researchers we can be 'neither totally objective nor unquestionably certain' (Crotty, 2003). We are capturing our data through participant reports but are not interpreting them as reality with unwarranted assertability (Crotty, 2003). We thus consider the response

Table 4 Relationship between approach to learning preference and response to Anatomy Learning Experiences Questionnaire.

Question	Approach to learning	Kruskal–Wallis *P*-value
1. I find/found reading textbooks an effective way of learning anatomy	Deep	0.037
13. I find/found the amount of anatomy I need/ed to learn daunting	Surface	0.000
15. I have problems learning anatomy because I don't see the point to it	Surface	0.000
16. I have problems learning anatomy because the teaching styles do not suit me	Surface	0.019
18. My main motivation for learning anatomy is to pass exams	Surface	0.000
19. I find anatomy learning difficult because it is memorization based	Surface	0.000
20. I struggle to build on my anatomy knowledge as I often forget what I learnt last semester/year/s	Surface	0.000
22. I have problems using my anatomy knowledge because I am not confident in my knowledge base	Surface	0.001
29. I feel that working with cadaveric material is an important part of becoming a doctor/dentist/health care professional	Deep	0.000

Table 5 Relationship between gender and response to Anatomy Learning Experiences Questionnaire.

Question	*P*-value	Male or female dominant (M/F)
13. I find/found the amount of anatomy I need/ed to learn daunting	0.031	F
19. I find anatomy learning difficult because it is memorization based	0.019	F
20. I struggle to build on my anatomy knowledge as I often forget what I learnt last semester/year/s	0.034	F
22. I have problems using my anatomy knowledge because I am not confident in my knowledge base	0.015	F

rate to be good and reflective of the population. The gender ratios are also reflective of the entire population (Table 1).

Approaches to learning

Overall, the majority of students favoured either a deep or strategic approach (Table 2), with a slight majority in dentistry favouring a strategic approach. All three approaches – deep, strategic and surface – were observed in students' experiences from the focus groups. In exploring whether gender exerted an effect on the approach to learning, it was found that a strategic and surface approach was favoured by a significantly larger number of females ($P = 0.009$ and $P = 0.003$, respectively). For students adopting a deep approach, no significant difference was found; however, more males (117) than females (110) adopted this approach.

Anatomy learning experience

In exploring students' experiences of learning anatomy, many students exhibited the same perceptions and experiences, for example: all students responded highly to the statement 'I feel that working with cadaveric material is an important part of becoming a doctor/dentist/health care professional'. A strong response to this statement was also associated with students adopting a deep approach ($P = 0.0001$). Students also commonly highly rated course handbooks and mock examinations as being helpful for their learning.

Some noticeable differences could be seen between students studying for different professions (Table 3). Dental students responded to being able to use their knowledge more than other groups ($P = 0.0001$). Medical students found the dissecting environment an intimidating one and subsequently reported finding online resources helpful ($P = 0.015$ and 0.003, respectively). Speech and language science students reported that they experienced greater difficulties with learning anatomy; they reported finding the amount to learn daunting ($P = 0.007$), struggled to remember what they did last semester ($P = 0.032$) and were not confident in their knowledge base ($P = 0.0001$).

Focus group trends

Analysis of the focus groups using nodal analysis from the transcripts of medical and dental students and moderation by the research team identified three key trends.

Genres of learning

When describing learning, different learning activities can be divided into genres, often based around a set curricular activity (Calkins et al., 2009). Although there were two separate and quite different courses involved in the focus groups (medicine and dentistry), in both cases students were learning anatomy in the first 2 years of their course.

Students in these courses at both institutions reported that their view of the role of the lecture was to summarize and to provide a theoretical perspective. At some point either after or sometimes before the lecture, students reported that they engaged in an amount of preparation work for the practical session. In some cases this resulted in almost a day's work! Preparation could involve any of the following activities; highlighting text in supplied practical handbooks, reading, drawing, colouring in pictures, watching DVDs, printing diagrams, creating lists of things to see. It was interesting that one medical student commented that good preparation work enabled you to ask good questions in the practical. This was reflected in a number of quotes, for example from a Year 1 medical student. *'I can't actually ask about this because I don't understand it enough to be able to ask a question yet'.*

During the practical session the activities students undertook varied but there was the sense for all groups that it was an opportunity to see and feel and talk with members of staff. After the practical, further work occurred that could include reading, watching DVDs, interaction with testing material, and looking things up, but the time devoted to these activities seemed to be less than the time devoted to the preparation work.

Difficulties encountered in learning anatomy

A common theme appropriate to many courses but perhaps even more allied to a professional course such as dentistry and medicine was the constraints on the time available for study. This affected many areas of students' work, from the preparation time, to the time in a laboratory setting, to the revision time. Anatomy appeared to be heavily time-dependent, with a number of students observing that the hours of study required for anatomy were greater than for other subjects. Possibly linked to the time constraints is the perception that in anatomy there is too much to learn, too much detail, with students reported being unsure as to the depth of knowledge required. As a result of this perception, there was the feeling that there were too many names and mnemonics to learn. Taken together, this would imply the adoption of a surface approach to learning anatomy. Such issues are highlighted by a quote from a Year 1 dental student: *'I really have a problem with all the nerves in the head and neck. And I don't really get don't know the names of each, I get confused with all the nerves'.*

A lack of relevance or understanding as to why the material was important was noted as a hindrance, although there appeared to be an amount of trust: *'they must know what we need to learn, so we learn it'*.

Students also struggled with the three-dimensional component, and especially reported having difficulty with orientation and judging scale. Students reported some negative feelings, which are interlinked – lack of confidence, lack of confirmation and never being 100% sure that they had identified something correctly.

Factors promoting or stimulating learning

A major factor stimulating learning of anatomy was being able both to see and feel structures in the practical. A Year 2 medical student described it this way: *'I think it is good to see it on a real body as opposed to just visualizing it or something else, even when you look it up in a text book and you get in the Dissecting Room (DR) and you realize it is completely different and I am sure again it's different in a live specimen in a surgical setting'.*

An understanding of the relevance of the material helped students' motivation to learn, especially when other parts of the course required them to apply knowledge in a professional setting; this was sometimes described as parts coming together. Working with other students in the class in the form of peer teaching was described as helpful; it appears that this was informally organized among friends or colleagues who work in a similar way.

Discussion

Syllabuses in medical and dental education display many similarities: in the methods of teaching adopted, which frequently differ from the methods students have been used to, the fact that a variety of disciplines are taught, the breadth of new information students are required to grasp, and that new skills and attitudes have to be mastered. A large common denominator is the study of the human form and hence it is therefore not surprising that this study showed many similarities between the medical and dental students. As shown in Table 3, similar percentages of students from different courses are adopting a strategic approach to learning by preference. With assessment an inevitable and major part of professional courses, this result might be expected (even if it is a little disappointing), as students are responding to the pressures of their environments. However, should we as educators be satisfied with this? We believe not. If we are seeking to develop deeper approaches to learning we need to design assessment tasks that reward a deep approach to learning as well as reinforce already grasped concepts (Logan & Marskak, 2011). We also need to be aware of the different roles of anatomy in different professions that are required to study it as a part of their initial education and how this might relate to different deep and surface learning requirements between different student groups. Thus, assessment design will also need to reflect those different requirements and emphasize the different relevancies that anatomy will have for students studying for different professions.

In common with many other studies and the perceptions of professional anatomists (Winklemann, 2007; Plaisant et al., 2011) we found that, irrespective of the profession, students studying anatomy recognized that using dissecting room specimens was of benefit to their learning. This three-dimensional and practical subject requires examination of the human form both in the living form and in cadavers.

The findings from our study provide yet more support for retaining anatomical specimens as part of undergraduate education in anatomy.

The pressures on students to learn and succeed are considerable (Smith & Mathias, 2007a,b, 2010). Students know that they must pass examinations if they are to progress in their chosen course. There is also the pressure of the need to perform in an occupational role. At the outset of a course the perceptions of what that occupational role might be may not always be fully formed or an accurate reflection of what the profession might involve. It is not surprising that students are driven by assessment and report mock examinations as an effective way of learning. All students highly favoured clinically based teaching, demonstrating the relevance and application of knowledge and skills. Interlinked with the application, all students understood that learning anatomy was important for their future career, as other studies have found (Ahmed et al., 2010). However, if students have an inaccurate impression of what they might be undertaking when they qualify, then the relevance of the studies might be harder to reinforce. Dental students will have a reasonably clear notion of their future role, whereas students of Speech Sciences may not appreciate how important anatomy could be to their future were they to become involved with voice or swallowing disorders. Medical students might occupy a middle position here.

In exploring the differences between the groups (Table 3), dental students reported a greater confidence in using their surface and radiographic knowledge. The authors found this interesting because, when examining the curriculum, dental students had less exposure to radiological and surface anatomy compare with medical students. Interestingly, Lindemann et al. (2001) found that dental students used more achieving methods than medical students on entry, but at graduation they were more similar, so perhaps dental students can see the purpose of such material earlier on and feel more confident with it.

Speech and language science students exhibited more negative perceptions. These perceptions, together with those associated with a surface approach (lack of confidence, volume to learn daunting, do not see the point, find it memorization-based, are only learning it for exams, etc.) all reflect various interlinked learning difficulties. Such interlinking difficulties may result in failure to complete the course or a lack of confidence in their knowledge, as found by Bhangu et al. (2010). One explanation for this could be a failure to appreciate the relevance of the subject, leading to the perception of a lot of material needing to be learnt simply to progress. This would be expected to reinforce a surface approach.

Theory

The authors would like to propose that at the early stages of learning content-rich subjects such as anatomy, adoption of some of the perceptions associated with a surface approach to learning is probably very common in undergraduate students and such perceptions may result, at least initially, in a surface-approach being used. The point needs to be made here that we would not regard surface learning as invariably something to be avoided, or that only deep learning should be fostered. As Hattie (2009) points out, there needs to be a balance between surface and deep learning; without any surface learning, deep learning cannot occur in a subject. We would argue that in anatomy the burden of surface learning that needs to precede understanding is unusually high in comparison with some subjects. Arguably it is the amount of surface learning that students must initially undertake that is a significant barrier for some. If that is accepted as the case, this may be one of the barriers experienced by students to gaining a full understanding of the subject and comes from a failure to cross this barrier because they become daunted by the burden. Thus adequate surface learning, knowing the subject, may be more important in a subject such as anatomy at the initial stages of subject mastery on the way to deeper learning.

This presents a significant challenge for assessment design as assessments, on the one hand, should encourage students to learn sufficient anatomy to manipulate concepts but, on the other hand, should seek to foster deep learning typologies. This is because although surface learning involves knowing a fact, learning at this level can result in quite limited levels of understanding and will not lead to relational or elaborated thinking characteristic of deep learners (Hattie, 2009). In relational thinking, learners are able to bring together more than one set of facts and/or organize and classify knowledge. Elaborated thinking is defined as a further stage of thinking and involves taking knowledge thus organized and using it to deduce rules or concepts. Hattie (2009) argues that a further kind of learning can be identified which he terms constructed learning, where learners become able to shape their own ideas and so construct new knowledge for themselves, allowing them to develop general rules and make predictions. Clearly, we would wish to move our students into these more elaborate forms of learning as the means to help them apply their knowledge, but also as part of a virtuous circle in which they can see the relevance of what they are learning to their future clinical practice, which serves as a further motivation to learn. Recent evidence shows that anatomical knowledge and understanding is used most in diagnosis (Lazarus et al., 2012). Such constructed learning may be one of the links between deep learning and knowledge restructuring and encapsulation that is proposed in illness script formations (Schmidt & Rikers, 2007).

If one threshold can be represented simply by the amount of knowledge necessary to be able to manipulate concepts, a possible further threshold, but this time of understanding, is suggested by the work of Meyer & Land (2003). They

developed the idea that within subjects there are threshold concepts, concepts which form conceptual gateways to subjects which are necessary to grasp if progress is to be made in understanding a topic. This underlies the point that memorization alone, characteristic of surface learning, will not allow students to progress in a subject. In anatomy, students have to engage in surface learning to be able to manipulate concepts that then allow a deep understanding, but the work of Meyer & Land (2003) would suggest this has to be combined with mastery of difficult topics. Concepts that represent these thresholds may be common across different student groups but it should not be expected that this would be invariably the case. Different courses with their different entry requirements will attract students of differing backgrounds. Consequently, the difficulties they experience with threshold concepts may also differ.

A further potential difficulty faced by some students studying anatomy, as it involves study of human cadavers, is the anxiety they may experience with this aspect of the subject, as reported by Plaisant et al. (2009, 2011). Since we know that deep understanding of anatomy is at least partly dependent upon a three-dimensional understanding of the subject (Fernandez et al., 2011) this anxiety might represent a further barrier for some of our students.

Limitations

The authors recognize the limitations of this study. It has utilized experiences from different institutions and it could be argued that they are too different to compare; however, the level of study and teaching modes are relatively similar. The sample is representative of approximately 45.6% of the population; this may be considered small but we set out to explore and gain understanding rather than to represent every aspect.

Concluding remarks

The study's findings highlight that the differences seen are elements controlled by course design and teaching rather than inherent in anatomy as a discipline. For example, the use of textbooks or online resources is influenced by what the curriculum and teachers are pointing students towards; and the lack of relevance as perceived by the speech and language science students and negative feelings are possibly related to how anatomy is integrated into the curriculum. These are elements that we as educators have the power to influence.

Following this study, a resource comprising a power point presentation with a video and light-hearted animation has been created for students to help them understand their approach to learning; this is receiving favourable feedback.

As students move through a curriculum, the longitudinal and often spiral nature means students come back to topics. Advice on learning should be appropriately placed throughout the curriculum. It may be necessary to recognize that in the early stages of a new topic a surface approach is needed but there should be the opportunity and support for further development of clinical engagement to enable a student to advance towards deep learning. It might also be necessary to question the idea that surface learning is bad and deep learning is good (Hattie, 2009). What is required is a balance between these two activities as a means to move students onto more constructed forms of knowing that will be of use in clinical practice.

Acknowledgements

The authors would like to express their gratitude to Ignacio González, Assistant Professor in Anatomy at Universidad Complutense de Madrid, for his involvement in the English–Spanish translation and for his assistance with the questionnaire data collection. We are very grateful to all students who participated in this study and thank them for their time and involvement.

References

Ahmed K, Rowland S, Patel V, et al. (2010) Is the structure of anatomy curriculum adequate for safe medical practice? *Surgeon* **8**, 318–324.

Anatomy Learning Experience Questionnaire. http://www.anatsoc.org.uk/Education/LinksEducationResearchTools.aspx

Bhangu A, Boutefnouchet T, Yong X, et al. (2010) A three-year prospective longitudinal cohort study of medical students' attitudes toward anatomy teaching and their career aspirations. *Anat Sci Edu* **3**, 184–190.

Biggs J (1999) What the student does: teaching for enhanced learning. *High Educ Res Dev* **18**, 57–75.

Biggs J, Collis K (1982) *Evaluating the Quality of Learning: the SOLO taxonomy*. New York: Academic Press.

Biggs JB, Tang C (2011) *Teaching for Quality Learning at University*. 4th Edn. Maidenhead: Open University Press. pp. 480.

Bloom B, Englehart M, Furst E, et al. (1956) *Taxonomy of Educational Objectives: the classification of Educational Goals*. New York: David McKay.

Calkins S, Light G, Cox R (2009) *Learning and Teaching in Higher Education: The Reflective Professional*. London: Sage Publications.

Crotty J (2003) *The Foundation of Social Research: Meaning and Perspective in the Research Process*. London: Sage Publications.

Drake RL, Lowrie DJ Jr, Prewitt C (2002) Survey of gross anatomy, microscopic anatomy, neuroscience, and embryology in medical school curricula in the United States. *Anat Rec* **269**, 118–122.

Drake RL, McBride J, Lachman N, et al. (2009) Medical education in the anatomical sciences: the winds of change continue to blow. *Anat Sci Edu* **2**, 253–259.

Ellis H (2002) Medico-legal litigation and its links with surgical anatomy. *Surgery* **20**: i–ii.

Entwistle NJ (2006) 2006/10/03/. Approaches to Study Skills Inventory for Students. from http://www.ed.ac.uk/etl/publications.html#measurement.

Fernandez R, Dror I, Smith C (2011) Spatial abilities of expert clinical anatomists: comparison of abilities between novices, intermediates, and experts in Anatomy. *Anat Sci Edu* **4**, 1–8.

Glaser G, Strauss A (1999) The Discovery of Grounded Theory: Strategies for Qualitative Research. Chicago: Aldine.

Hattie J (2009) *Visible Learning: A synthesis of over 800 Meta-Analyses Relating to Achievement*. Abingdon: Routledge.

Kreber C (2002) Teaching excellence, teaching expertise and the scholarship of teaching. *Innov High Educ* **27**, 5–23.

Lazarus M, Chinchilli V, Leong S, et al. (2012) Perceptions of anatomy: critical components in the clinical setting. *Anat Sci Edu* **5**, 187–199.

Lindemann R, Duek J, Wilkerson L (2001) A comparison of changes in dental students' and medical students' approaches to learning during professional training. *Eur J Dent Educ* **5**, 162–167.

Logan J, Marskak D (2011) Testing to enhance retention in human anatomy. *Anat Sci Edu* **4**, 243–248.

Marton F, Pong W (2005) On the unit of description in phenomenography. *High Educ Res Dev* **24**, 335–348.

Meyer J, Land R (2003) Threshold Concepts and Troublesome Knowledge: Linkages to Ways of Thinking and Practising within the Disciplines, Enhancing Teaching-Learning Environments in Undergraduate Courses Project.Edinburgh:University of Edinburgh.

Moseley D, Baumfield V, Elliott J, et al. (2005) *Frameworks for Thinking: A Handbook for Teachers and Learning*. Cambridge: Cambridge University Press.

Older J (2006) 2006/07/17/. Anatomy: A must for teaching the next generation. from http://www.rcsed.ac.uk/journal/svol2_2/20200003.html.

Pandey P, Zimitat C (2007) Medical students' learning of anatomy: memorisation, understanding and visualisation. *Med Educ* **41**, 7–14.

Plaisant O, Toussaint P, Courtois R, et al. (2009) Assessing medical students' personality in relation to their behaviour and experience in the dissecting room. *J Anat* **215**, 705.

Plaisant O, Courtois R, Toussaint P, et al. (2011) Medical students' attitudes towards the dissecting room in relation to personailty. *Anat Sci Edu* **4**, 305–310.

Ramsden P (2003) Learning to teach in higher education.

Saljo R (1979) Learning about learning. *High Educ* **8**, 443–451.

Schmidt H, Rikers R (2007) How expertise develops in medicine: knowledge encapsulation and illness script formation. *Med Educ* **41**, 1133–1139.

Smith C, Mathias H (2007a) An investigation into medical students' approaches to anatomy learning in a sytems-based prosection course. *Clin Anat* **20**, 843–848.

Smith C, Mathias H (2007b) Educational perspectives on learning anatomy. *J Anat* **210**, 774.

Smith C, Mathias H (2009) Students' perceptions and approaches to learning anatomy in a systems based course using prosection and dissection. *J Anat* **214**, 786.

Smith C, Mathias H (2010) What impact does anatomy education have on clinical practice? *Clin Anat* **24**, 113–119.

Ward P (2011) First year medical students' approaches to study and their outcomes in a gross anatomy course. *Clin Anat* **24**, 120–127.

Winklemann A (2007) Anatomical dissection as a teaching method in medical school: a review of the evidence. *Med Educ* **41**, 15–22.