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Research Report

The initial impact of the Anatomical Society gross anatomy core syllabus for medicine in the United Kingdom: Student and staff perspectives.

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Running title: Impact of core syllabus

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ABSTRACT

'What do students studying medicine need to know' is an important question for curriculum planners, anatomy educators and students. The Core Regional Anatomy Syllabus (CRAS), published by the Anatomical Society in 2016, contains 156 learning outcomes (LOs) and has informed 'what needs to be known'. This project explored how CRAS had impacted undergraduate anatomy and anatomists in the United Kingdom. A cross sectional study was designed in two phases. Phase 1, involved a survey of students in clinical years (N = 164). Phase 2 included a survey of anatomist's views (n=50) and focus groups of anatomy educators (N = 16). The students' perspective showed that specific regions of CRAS are deemed less relevant. These were also the body areas where students perceived their anatomical knowledge to be more deficient. Only 46% (n=75) of students estimated that they knew over 50% (n=78) of the LOs. Phase two revealed that all anatomists were aware of the syllabus and 48% (n=24) had checked the CRAS against their own institutional LOs. Anatomists had shared CRAS with colleagues 64% (n=32) and students at 34% (n=17) respectively. Forty-six percent (n=23) of anatomists reported having changed their teaching in some way because of CRAS. The focus groups generated four key themes: 'support for CRAS', 'standardization and validation', 'professional identity' and 'limitations and leverage'. Overall CRAS has been well received and is establishing itself within the anatomical community as the new standard for anatomy teaching for medical students.

Keywords: gross anatomy education, medical education, undergraduate education, core syllabus, core curriculum, faculty perceptions, students' perceptions.

INTRODUCTION

Anatomy is a key component of any medical curriculum and is the cornerstone of good clinical practice (Davis et al., 2014). Anatomy education has changed significantly over the past 20 years (Drake et al., 2009, 2014) because of a dramatic reshaping of medical curricula to accommodate the introduction of newer topic areas (e.g., stem cell therapy, genomics) and the general trend of reducing direct teaching across all basic science subjects. This has created a need to sharpen the focus for anatomy and, where appropriate, reduce unnecessary detail (Turney, 2007; Davis et al., 2014; Smith et al., 2016a). A reduction in content must not impact upon the quality of teaching and therefore necessitates anatomy teachers use time effectively, at the same time also embedding foundational knowledge (Entwistle, 2009; Davies et al., 2014). To ensure the effective use of time, anatomy teaching now employs a far wider range of teaching resources than it has done previously. Alongside the traditional approaches of using cadaveric specimens, textbooks, didactic teaching sessions, surface anatomy and radiological anatomy as well as newer teaching methods such as ultrasound (Moscova et al., 2015; So et al., 2017) imaging techniques (Davis et al., 2014; Phillips et al., 2018), body painting (Finn, 2010), and three-dimensional (3D) printing (Drake and Pawlina, 2014; McMenamin et al., 2014; Smith et al., 2018).

Despite the introduction of new modes of delivery, there has been a reduction in time for teaching anatomy within the medical curriculum (Heylings, 2002; Drake et al., 2009; Smith and Mathias, 2010, 2011; Drake et al., 2014; Moxham et al., 2015). This has led some to suggest that the base anatomical knowledge of medical graduates is falling to a level that is below a

minimally acceptable standard to ensure safe patient care (Goodwin, 2000; Kahan et al., 2001; Ellis, 2002; Kidder, 2002; Lynn-Macrae et al., 2004; Prince et al., 2005). However, the evidence available is predominantly based on doctors training the new training standards for doctors were implemented and at time where no core syllabi in anatomy were in active use.

Core syllabi in anatomical sciences

As a response to the need to define a standard for the content of anatomy programs, a number of core syllabi in anatomical sciences: gross anatomy (Leonard et al., 1996; Griffioen et al., 1999; McHanwell et al., 2007; Smith et al., 2016a; Connolly et al., 2018; Finn et al., 2018), head and neck anatomy (Tubbs et al., 2014; Tubbs and Paulk, 2015), oral anatomy, histology, embryology, and teratology (Fakoya et al., 2017; Moxham et al., 2018) and neuroanatomy (Moxham et al., 2015); have been published. Core syllabi also exist in clinical disciplines such as: palliative medicine (Kizawa et al., 2012), sport and exercise medicine (Humphries et al., 2018), child health (Jacob and Fertleman, 2017), and respiratory medicine (Loddenkemper et al. 2006). The Anatomical Society published its first 'Core Regional Anatomy Syllabus' (CRAS1) for undergraduate medical students in 2003. This was partly in response to the lack of detailed guidance on curriculum content from any institutions including the UK's General Medical Council (GMC, 2018). Further refinements to CRAS1 were made and the resulting syllabus (CRAS2) was published in 2007 (McHanwell et al., 2007). This revised CRAS2 syllabus was incorporated by the GMC as a reference document in Tomorrow's Doctors to guide the teaching of anatomy (GMC, 2016). The GMC'S Tomorrow's Doctors review aimed to declutter the content of curricula and focus on producing undifferentiated doctors who could enter the

National Health Service (NHS) as safe practioners. The key difference between CRAS1 and CRAS2 was a more systematic approach adopted to frame the learning outcomes within the syllabus. After nearly ten years in use, the Anatomical Society thought it timely to revisit the content of CRAS2. At the same time this provided an opportunity to respond to criticism regarding the simple consensus approach that produced CRAS2. For CRAS3, the syllabus was generated using a recognized consensus methodology: the Delphi technique (Smith et al., 2016a). Another difference between CRAS2 and CRAS3 was the focus, where the latter looked exclusively at gross anatomy and removed any sub-disciplines, such as neuroanatomy from its remit.

The term core curriculum is sometimes used interchangeably with the term syllabus and confusion over the terms has been documented (Burton and McDonald, 2001). However, the term curriculum means not just the content of a course but the means or the framework that is in place to deliver that content and structure the learning process (Moxham et al., 2014). The curriculum subsumes a syllabus. In this instance the term syllabus is employed to express learning outcomes in relation to topic content (Altman, 1989). The Anatomical Society syllabus through all its revisions including CRAS3 (Smith et al., 2016a) has actively avoided being prescriptive about the 'how to deliver' element of a curriculum, leaving this to institutional and educator preference. Giving a core syllabus rather than a core curriculum means the focus is on terminal outputs rather than imposing or determining how they are achieved. The term 'core' reflects central knowledge to achieve safe clinical practice (Fakoya et al., 2017).

The Delphi Process is a well-established method used to obtain consensus and establish agreement between a panel of experts, focusing on a single, specified issue (Keeney et al., 2011, Smith et al., 2016a). It does so by gathering the collegial knowledge held by experts in a field or discipline including professional knowledge that is known but not necessarily discussed or written down). The process has been used in a wide variety of situations including informing change to curricula within healthcare settings (Moxham et al., 2014; Tubbs et al., 2014). The CRAS3 Delphi panel consisted of a team of 39 experts including anatomists and clinicians with at least five years of experience teaching medical students (Smith et al., 2016a)

Assessing the societal impact or value of educational research or intervention is challenging (Greenhaigh and Fahy, 2014) and this is particularly true when measuring the impact of new syllabi (Bornmann, 2017). Part of the complexity is because there are many target groups involved; in the case of CRAS3 this included students, medical graduates, academic staff, curriculum planners within institutions, discipline-specific professional bodies, regulatory bodies setting standards and controlling entry to the medical profession and postgraduate educators. Impact will also often take a long time to be fully felt not least because major curriculum reviews, in complex professional courses such as medicine, are not something undertaken frequently. The goal of this study was to capture some initial evidence of impact from CRAS3, by sampling the reactions of students to the new syllabus and the opinions of anatomists responsible for teaching medical students.

Aim and Inquiry Questions

The aim of this study was to understand the effects from the introduction of the core syllabus on undergraduate medical education. The questions posed were: (1). What relevance do the learning objectives (LO) have to student's current and future practice and what are students' perceptions of where they feel deficient in anatomical knowledge? (2). How has the CRAS impacted on undergraduate anatomy, from the perspectives of anatomists. If there has been impact, what form does this early impact take?

MATERIALS AND METHODS

The study was divided into two phases utilizing a mixed-method sequential strategy (Creswell, 2014) and involved the collection and analysis of both quantitative and qualitative data. Phase one sought to explore the perceptions of students. Phase two evaluated the experiences and perceptions of anatomists. The study gained ethical approval from the Research Governance and Ethics Committee at Brighton and Sussex Medical School (BSMS), University of Sussex (15/089/SMI).

For Phase 1 this study used a hypothesis that sought to test that students will rank all LOs as essential. Phase 1 was undertaken at BSMS where the anatomy provision includes a dissection and prosection laboratory. Medical students study anatomy as part of system-based modules in years one, two and four. Within the systems-based modules a typical structure for anatomy is a series of lectures that occur before laboratory-based dissection and prosection sessions. In addition, students are taught using surface anatomy and ultrasound sessions. The total number of hours devoted to anatomy is 230. Further information on the anatomy provision and medical curriculum is described in Smith et al., 2018.

Phase 2 included perceptions of anatomists from around the United Kingdom. It tested the hypothesis that the CRAS3 provided valued guidance for UK anatomists teaching anatomy to medical students.

Phase 1. Student perceptions of the syllabus

Students in years 3 to 5 of the undergraduate medical course (n = 391, Year 3 = 139, Year 4 = 120, and Year 5 = 132) were invited to complete a survey to establish students perceptions of relevance of the LO in CRAS3. The survey involved two components; A. The 156 LOs to be reviewed and B, 6 items relating to experience and deficiencies. In part A, students were required to rank each LO as to whether they perceived it as “essential” “important”, “acceptable” or “not required”. These terms were defined for students at the beginning of the survey. The terms were used as defined in Smith et al., 2016b. In part A, an open comments text box was provided at the end of each ‘body region’ section to allow students to comment on the reasons for their decisions or to make any other comments related to the statements being reviewed. In Part B, 6 items asked BSMS students to comment on their perceptions of their anatomical knowledge at BSMS at their respective stages of study (Table 1). Some limited demographic data were also gathered (year of study, gender, previous educational background) making a total of 165 items in the survey.

Prior to the survey being distributed, the data collection form was checked and piloted within the research team. To promote participation, the survey was created as both a paper copy and

an on-line version using Bristol Online Survey (Bristol Online Survey, 2017). Using either method the survey took around 30 minutes to complete, no incentives were offered. For the online survey students could not save their responses and return later. They were informed of this in advance. The paper copies were distributed to the students during coffee and lunch breaks on lecture days and were collected before the next teaching session began. Students were instructed to complete the survey on their own and not to consult with colleagues. The data gathered from the paper copies of the survey were added into the Bristol Online Survey (BOS) system and all survey results were exported to Microsoft Excel® (Microsoft Corp., Redmond, WA). The online survey remained open for four weeks to maximize participation. Data from the paper surveys were inputted by hand and then random sampling was performed using a random number generator to check for consistency. The survey was analyzed in IBM SPSS statistical package, Version 24.0 (IBM Corp., Armonk, NY). To test for internal consistency a Cronbach's Alpha was performed (0.985).

Phase 2. Perspectives of anatomists

To gain an understanding of the use of the syllabus a 17-question survey was developed (Table 3). The survey was piloted at BSMS with five anatomy demonstrators (junior doctors) to assess ease of understanding of the questions and to check the answers given were congruent with the aims of the study. These pilot responses were not included in the study. The survey was distributed in paper form at an Anatomical Society Summer meeting in 2016. The inclusion criteria were anatomists who were actively engaged in teaching gross anatomy to medical students. In 2017 to ensure as many individuals' views as possible were considered the survey

was added to Survey Monkey (SurveyMonkey Inc., San Mateo, CA) to capture the views of those anatomists unable to attend the meeting and then this was distributed to anatomists. Three demographic questions (Job role, how they had found out about CRAS3, and method of teaching) were included and the responses are shown in Table 4. The survey was analyzed using the IBM SPSS statistical package, Version 24.0 (IBM Corp., Armonk, NY). Analysis included descriptive statistics for the eight components where numerical data had been gathered. Three Kruskal Wallis tests were performed to ascertain if there were any relationships between (1), Job Level and the seven remaining questions, (2), How the individual found out about the CRAS and remaining questions and (3), the method of teaching used and the remaining questions. To test for internal consistency a Cronbach's Alpha was performed (0.251). With only 50 responses to eight numerical questions the response rate was considered too low for the Cronbach's Alpha to represent a true value. The free text questions were analyzed using thematic coding and counting of recurring themes.

To gain a deeper qualitative understanding of the use of the syllabus by anatomy teaching staff a series of focus group interviews were undertaken. The methodology employed for the focus groups were based on the principles of qualitative interviewing but adapted for focus groups to allow a thematic topic centered discussion (Mason, 2002). A series of focus groups were advertised during the same Anatomical Society Summer meeting in 2016. Though some focus group participants could have already responded to the survey, the research team considered this not to be an issue because the focus groups would inevitably expand further upon the topics contained with the quantitative survey. Individuals who wished to take part were invited

to sign up for a given focus group at the registration desk. Four focus groups took place with a total of 16 participants overall. It was determined that each focus group should have a maximum of six participants and a minimum of two (Mason, 2002). The focus groups were continued for up to 60 minutes or until no new subjects emerged. The focus group were recorded and transcribed verbatim. Three starter questions were designed to assist with the focus of the session and formed the starting point of the discussion. The first question included demographics such as employment and role. The second and third question asked individuals to list the perceived value and usage of the CRAS3. Participants were asked to write down their answers and these formed the basis for the initial discussion. Placing the discussion of the focus groups in context allowed for thematic analysis (Braun and Clark, 1967), the analysis looked at the perceived value and usage of CRAS3 and grouped them according to themed content.

Transcripts were analyzed and coded for recurring themes by one researcher (CS). A summary of the codes and themes were then written down. Independently three other members of the research team (SM, CH and GF) reviewed the transcripts and wrote summaries of the themes they felt had emerged. At a meeting, all summaries were reviewed, and any differences negotiated in order to achieve to agreement.

RESULTS

Phase 1. Student perceptions of the syllabus

A total of 164 survey responses were received from students; The rates of survey responses received from students were; 74 from Year 3, (53%), 48 from Year 4, (40%) and 42 from Year 5, (32%).

Perceived relevance of Learning Objectives within the Core Regional Anatomy Syllabus 3 (CRAS3). Figure 1 demonstrates how students perceived the importance or relevance of each learning outcome by anatomical region. Within each region of the CRAS3, student perceptions varied as to the proportion of LOs they perceived as "essential", "important", "acceptable" and "not required". Students ranked a higher proportion of LOs regarding anatomical terms, abdomen, thorax and vertebral column as "essential". Students ranked the LO for the anatomical terms (flexion/extension etc.) as the highest with 74% (n=121) students stating them as "essential". The region that had the lowest proportion of LOs ranked as "essential" was head and neck with only 34% (n=56) students rating them as "essential".

For all anatomical regions, year 5 students perceived a higher proportion of the LO as "essential", except for head and neck and vertebral column (Figure 2). 4th year students perceived a higher proportion of head and neck and vertebral column LOs as being essential compared to both 3rd and 5th years. A marginal difference was seen between 4th years and 5th years for the vertebral column. Yet, 4th year students perceived over 10% more of the LOs in head and neck as "essential" compared to the 3rd and 5th year students.

As well as ranking the LOs according to their perceived relevance, some students provided free text comments detailing factors that contributed to relevance of the LOs, justifying the reason(s) for their decisions. There were two recurring reasons given for a negative perception of the relevance of knowledge in a particular topic. These were lack of clinical exposure or less teaching time devoted to that topic. If students had seen the knowledge being applied in a clinical context they were more likely to appreciate the relevance of that topic to their learning: *"I think its depends on the clinical attachment/rotation you are on. But the 1st 3 LOs are essential as they underlie a lot of clinical practice." Year 3 Student.* The relevance of anatomical knowledge was also related to the exposure students had to it: *"Have not done a neuro attachment yet so currently can't appreciate the importance of some of the LOs." Year 3 Student. "Obviously [LOs are] more relevant depending upon which specialty one chooses and whether there are life-threatening consequences/emergencies associated with these structures that need to be recognized." – Year 4 Student.* As well as exposure to LOs, the extent that anatomical knowledge could be applied outside specific specialties influenced student perceptions. Consideration was given to how relevant some of the LOs were, given their current stage of training: *"Does not seem important in the first few years, but going back to my anatomy notes has really helped my 5th year revision." - Year 5 Student.*

Perceived deficiencies in anatomical knowledge. To explore perceived deficiencies in knowledge, students were asked to estimate the percentage of LOs they felt they knew. Most students (70.3%) felt that they knew at least 50% of the LOs contained within CRAS3. Only 46% of students felt they knew more than 50% of the LOs and no students estimated that they knew

all LOs described by the CRAS3. Perhaps of concern is the 29.6% of students who felt they knew less than 50% of CRAS3. Figure 3 compares the percentage of LOs that students thought they knew, by year group. The year group that showed the biggest spread of data were the year 3 students. The ranking given by year 3 students per LO varied between 10% and 90%; a range that was surprisingly large.

Perceived deficiencies in knowledge were also elicited by asking students to identify specific anatomical regions where they felt their knowledge to be deficient, and then to give reasons for this. Table 2 shows the number of students who thought their knowledge to be deficient in different regions of the CRAS3, by year group and overall. Across the year groups, there were similarities in the anatomical regions where students felt their knowledge was deficient in.

The regions where the greatest number of students felt their knowledge was deficient (head and neck, pelvis and perineum, lower limb, vertebral column and upper limb). This seemed partly to reflect a perception by the students of anatomical regions they felt to be least relevant to them. Overall, 42 (34.6%) students felt that they were not deficient in any region of the CRAS3. The proportion of students in each year who felt they were not deficient in any region of the CRAS3 was lower amongst 3rd year (18.9% of students) and, 4th year (22.9% of students), compared to 40.5% of 5th year students.

Students attributed deficiencies in knowledge to the lack of exposure to anatomical knowledge within the clinical environment and teaching sessions, this included the amount of repetition

that occurred in both settings. Teaching and learning in a clinically relevant context was thought to reduce deficiencies in anatomical knowledge: *"Detailed knowledge of most of the areas isn't required in everyday practice which means I have quickly forgotten a lot having been on clinical placements for the past few years. When not on surgery placements, very minimal anatomy knowledge is required." – Year 5 Student". "As you go through the clinical years, your focus changes to clinically relevant anatomy rather than just knowing all anatomy." – Year 5 Student".*

Phase 2. Perceptions of anatomists

The quantitative survey generated 57 responses. Four were incomplete and so were removed. Three were from students who did not teach anatomy, and these were also removed. To enable the focus of this paper to be perceptions from the UK and Ireland, five international responses were removed (although incidentally they did support the perceptions of UK anatomists). Table 4 details the responses. The participant group included a wide range of different academic career levels and a mixture in the main method of teaching employed in their institution. In answer to the question how they found out about the new syllabus, these were grouped by the researchers into five categories (Professional body, Internet, Word of Mouth/Personal communication, Publication and Not provided). The highest percent (36%) was through professional societies (Table 4).

All participants were aware of CRAS3 and 48% had checked their own LOs against it, 46% had changed their teaching because of CRAS3. Analysis of free text comments showed that the most

common impact was the small amendments that individuals made to their institutional LOs to include or exclude different anatomical components (e.g. musculo-skeletal anatomy, breast anatomy). Within that 48% of institutions who had checked their LOs against CRAS3 three had undertaken a larger review of their curriculum. One of three outcomes resulted from that review either: (1) developing a new curriculum, (2) linking all lecture and practical material in a mapping exercise based on CRAS3 and (3) creating optional modules that dealt with material not covered by CRAS3. There was no statistically significant relationship between the level of role participants assigned to themselves and how they discovered CRAS3 or the method employed in teaching.

The question concerning areas felt to be missing from the syllabus was answered by four respondents who listed; ventricles of the brain (x 2), hyoid bone and anatomical variation. When asked if any area was over-taught neuroanatomy was identified by four respondents (although neuroanatomy is not included in CRAS3). In contrast nasal sinuses, back muscles, pharynx, foot, pelvis and head and neck (x 2) were areas thought to be under taught. Neuroanatomy and anatomy of the head and neck were identified by 14 respondents as the areas that require the greatest amount of teaching time. Two respondents felt the anatomy of the limbs required the greatest amount of time. Ten respondents felt that the CRAS3 should be delivered in the preclinical phase (first two years) of medical school and 12 felt it should be delivered throughout the course of an undergraduate medical degree.

When asked what resources were needed to deliver CRAS3, the answers included, more staff (7 responses), followed by more time (6 responses) and then more resources including clinical input (5 responses). The remaining 32 anatomists made no comments about resources.

When asked how the syllabus had generated conversation or debate within your network, four individuals simply replied that "it had". Twelve respondents included examples of what was relevant or reflected on how anatomy and medical education had changed, shown by the following quotes: "*we felt there was a gap in learning outcomes and we discussed adding new ones"*, and "*presented it to managers to demonstrate we needed more time!"* Participants described how they didn't only discuss CRAS3 within their networks but used it to ask for curriculum changes. Participants reported that the next syllabus they would like produced is embryology (7 responses), neuroanatomy (6 responses) and histology (3 responses).

Focus Groups

The four focus groups involved 16 anatomists. The sample was mixed in gender (9 female, 7 male) and included a mixture of academic levels, including; assistant, associate and full professors. All taught medical students and, as well, a range of allied health care students. Geographical distribution included anatomists from England, Northern Ireland, Scotland, Wales, and Republic of Ireland.

The starter questions in the focus group asked individuals what was the perceived value and usage of the CRAS3. The content of the responses focused on validation and standardization

(n=5 and 9, respectively) regarding the anatomy content being taught at participant's respective institutions. Other comments focused on CRAS3 supporting staff: *"allows a dialogue with others at different institutions ensures we are all singing from the same song sheet".*

The analysis of the focus group transcripts revealed four key themes: support for CRAS, standardization and validation, professional identity, limitations and leverage.

Support for The Core Regional Anatomy Syllabus

There was praise for the CRAS3, especially that it met a clear need with regards to standardization. There was also praise for how it had increased the exchange and discussion between institutions on how they then deliver the CRAS3. It was commented that it gave local freedom to explore strengths of teachers and to adapt to local needs of medicine in each population. Where participants had given the CRAS3 to students they reported that it had helped students see the overall picture of their education and gave students reassurance that it was not just the lecturer who had decided what they needed to know: *"I make sure the students know where to find it, one risk is it becomes a checklist!".* Participants also commented the inclusion of clinical imaging was very well-received. The reason given for this being that it gave a direct link to the application of anatomy knowledge directly to clinical scenarios.

Anatomists felt that there was a gap between CRAS3 and post qualifying examinations, such as membership of the Royal College of Surgeons. It was felt that CRAS3 was suitable until graduation but then there was no guidance provided or continued into later training. There

were also requests for a CRAS for specific groups e.g. Pharmacy and for other areas taught by anatomists e.g. neuroanatomy, embryology: *"I was going to suggest [producing a syllabus for] embryology. It's a pity that neuroanatomy was taken out, so a neuro one too".* Individuals also asked for the CRAS3 to be available in different formats e.g. word files, excel so that it would more easily integrate into their own curriculum documentation. When considering the overall aim of CRAS3 it is well represented in the quote: "*The ultimate goal would be you turn out doctors that were competent, or at least not dangerous*".

Standardization and validation

A large part of the discussions focused on the overall aim of medical education, to produce safe and effective medical practioners. Also discussed was the perceived value in ensuring that students from different institutions should have the same body of knowledge. "*It's always nice to know that what you're doing is what you should be doing…and see what everybody else is doing*". They reflected that the CRAS3 allowed educators to check if an area was under or over represented in the curriculum: *"You can easily find where the gaps are".*

The aspect of validation was discussed in different forms. There was the formal part of the CRAS3 being published by a learned society of high standing and the fact that the GMC have referenced it: *"It's like authority".* There was the less formal part of the feeling that it has become, in their terms, the 'gold standard' amongst teachers: "*We use them as a gold standard*". This also involved including junior colleagues who were aware of it through senior colleagues using it or recommending it: *"My boss has embraced it. He's the one who gave it to*

me. We've actually taken it on board with enthusiasm". Validation was perceived as part of the rigorous and stringent Delphi process in that the Delphi panel included a range of stakeholders from different medical and surgical specialties, reflecting that it was not just the views of anatomists' that were being represented: "*It's (CRAS3) been through an iterative process with clinicians and anatomists, so we can stand over it a little bit more strongly and its published in leading journal".*

Professional identity

It was reported that the CRAS3 gave junior colleagues confidence in what they were teaching. It helped build their professional identity as anatomists. The new syllabus had helped individuals to design new programs, not only in medicine but physician associate programs and other allied health profession programs: *"It also gives you confidence when you're planning a curriculum that you're actually in line with everybody else".* Participants reported that they were aware of how clinical colleagues comment on students lack of anatomical knowledge and the negative impact even jovial comments such as '*Oh my colleague from x institution knows no anatomy*' can have on a discipline. Participants felt that the CRAS3 had helped this as it was easy to reply to such comments with *'they would have been taught and assessed on this document'*. There were a lot of positive feelings about CRAS3 and how it had created a joint sense of ownership '*it's our syllabus'* and that anatomy as a discipline was on a rebound.

Limitations and Leverage

Participants were concerned that the use of CRAS3 in later years of the program was still an area for development: *"The problem with clinicians incorporating is they just do one little bit of their specialty*". This may reflect internal curricula issues with vertical integration and spiraling. Some individuals reported that un-supportive superiors had been obstructive in implementation of CRAS3 feeling it would constrict the students learning: "*We don't want to limit their intellectual curiosity*".

Participants explained how CRAS3 had provided strength to discussions with colleagues and curriculum planners about the balance of teaching and resources. This particularly came out as the term '*Leverage*'. Individuals described some of their own challenges within their institutions. Participants reflected that the CRAS3 has enabled them to seek review to a number of aspects of their curricula. This has included: institutional review, more time, less time, more assessment, more information in handbooks: *"we actually use it actively to justify our systematic and scientific approach to medical teaching".*

DISCUSSION

The aim of this study was to understand how the core syllabus in anatomy might have begun to have impact upon anatomy teaching in undergraduate medical education. The study achieved this by looking at the perspectives of how educators and students perceive the syllabus and so how it might impact upon their learning. The study asked (1). What relevance do the learning objectives (LO) have to student's current and future practice and what are students' perceptions of where they feel deficient in anatomical knowledge? (2). How has the CRAS

impacted on undergraduate anatomy, from the perspectives of anatomists. If there has been impact, what form does this early impact take?

Student Perspectives

In exploring perceived deficiencies in knowledge, it might be expected that students would have difficulty in some areas. It is known that students studying neuroanatomy often struggle to master this complex topic and may experience a phenomenon that has been termed neurophobia (Jozefowicz, 1994; Javaid et al., 2018). Similarly students can also struggle to master aspects of head and neck anatomy. Yet, at the same time students ranked head and neck as more essential knowledge yet 55% felt deficient in this area. The reasons for feeling deficient may be numerous. It may be a reflection of the degree of difficulty of dissection, the time allocated to the teaching, the extent of the clinical exposure to this area, or the instructions for the use of prosections. It could also be that head and neck is often taught in the same module as neuroanatomy and that consequently neither subject is given sufficient time to be covered adequately.

Students' knowledge and their own ability to judge their knowledge has been shown to not always be congruent (Hall et al., 2016), however it is of concern that 29.6% of students felt they knew less than 50% of CRAS3. By the time students were approaching final examinations only 41% felt they were not deficient in anatomy knowledge. For the other 59%, the time before finals is very stressful and this may have exacerbated concerns for their level of knowledge, leading to an underestimate of their abilities. It is also possible that current generation Y

students are not using or understanding core syllabi for the purpose for which they were intended (Fornaciari and Dean, 2014), it is reported that a syllabus may be used as a contract; as a record; or as a learning tool (Parkes and Harris, 2002). However, Rumore (2016) argues that syllabi are not enforceable in the same way that legal contracts can be. Consequently, it may be that students are not viewing them as definitive statements of what they need to know. This may be especially to be the case amongst students who adopted a surface or strategic approach to learning anatomy in the early years (Smith and Mathias, 2007). This would fit with the ideas that the syllabi should be communication documents that are revisited frequently (Thompson, 2007).

Final year students perceived anatomy to be more essential and this may be due to students being able to see first-hand how their anatomy knowledge underpins many aspects of their clinical work. Anatomists try to ensure their teaching is in context, yet it is often only in later years that students understand the true contextual importance and relevance of anatomy. Only then is the true value of anatomy is understood. Perception of CRAS3 learning outcomes were also somewhat based on their clinical exposure. This underlines the value of a true spiral curriculum as originally articulated by Bruner (1960), where topics are revisited and but also elaborated throughout the course of a program. In doing this it allows students to understand topics at a level appropriate for their level of study, and then explore them at ever more advanced levels to progressively deepen their understanding (Olson, 2008). There are two things that follow from adopting this approach to curriculum design. The first is that anatomy should be longitudinally placed in the curriculum (Evans and Watt, 2005). The second is that an

adequate level of basic knowledge be established early on so that students can have a foundation of knowledge that can be revisited. Here the existence of a holistic syllabus such as CRAS3 can help to ensure the necessary continuity of learning. There is perhaps a subtler reason to pursue a more coherent approach to discipline-specific knowledge, that is it gives students greater access to powerful and predictive knowledge (Young, 2008). In deepening understanding by this approach rather than employing strategic approaches to learning could have the capacity to increase the confidence of practitioners once in practice.

Anatomist perspective

The study has confirmed that the CRAS3 has had an impact on both anatomy education and anatomy educators. Just under half of all anatomists have told us they have changed their teaching because of its existence. This might be by adding a particular learning outcome or modifying outcomes they already have in their courses. The reasons why the other half of respondents felt there was no need to change their syllabus varied. In some cases, it was that they have already adapted their teaching in relation to CRAS2 or simply that their existing course mapped onto the Core Syllabus at the outset and so, in either case, no further changes were needed. In other cases, it was that educators have simply not engaged with the CRAS3 at all perhaps because they feel it is difficult to effect change within a complex program such as medicine where many competing pressures for time are felt. The impact of CRAS3 has involved the opening of boundaries to enable practice to be shared between colleagues and tacit pedagogic content knowledge to be made more explicit. Concern is often raised about the expectations placed on medical students regarding their the level of anatomical knowledge.

However, if it is placed too high, then students may be unnecessarily burdened, but placing it too low could compromise patient safety. Sharing of practice and continuing the conversation between medical practitioners and anatomy educators regarding anatomy knowledge is crucial in securing effective course design. This can be seen very much as part of a process of developing practitioners who are safe upon graduation. To say that the Core Syllabus will decrease the number of litigations associated with a deficit of anatomical understanding might be an unjustified-assumption. This is because it is not understood if the deficit lies at the level of the undifferentiated junior doctor, or later at the postgraduate specialist training level. The relationship between CRAS3 and litigation is complex and many different components create safe practice, knowledge based on CRAS3 is just one. The inclusion of CRAS3 by the GMC has for a better word provided the stick but what is the carrot?

The carrot has been the strength of feeling of collegiality amongst anatomists about the project. Anatomists strive to do the best by their students, so it might have been predicted by the authors of this paper that CRAS3 would be welcomed by their colleagues. However, they did not expect some of the feelings it provoked. In developing CRAS3 there was a continuous sharing about its progress at academic conferences (e.g. Anatomical Society meetings). This might have created 'buy in' from anatomists as the work emerged. Similarly, as the findings were fed-back many anatomists felt joint ownership. These sentiments are represented in the theme of developing professional identity that emerged in the focus group discussion, where the shared ownership and the proudness about CRAS3 were particularly evident. The importance of involvement from all stakeholders has also been shared in the UK in the

development of a child health core syllabi (Jacob and Fertleman, 2017). Frequently, there may only be one or two anatomists per institution so being able to share and confirm a level of anatomical content within a course against a nationally recognized document has been important and, in some cases, has provided evidence for or against curriculum changes.

Taking a wider perspective, it is important to consider why CRAS3 has had a positive reaction from anatomists in the United Kingdom, where some other core syllabi (e.g., Leonard et al., 1996) have not. Core syllabi cannot be merely a 'wish list' generated by anatomists. Many of the pre-existing core syllabi were unrealistic in their expectations of what was possible to cover within pre-clinical or early years of studying medicine. From the very outset the Anatomical Core Syllabus in its various iterations has adopted a principle of balancing what is desirable with what is necessary; "adding common sense to need to know" (McHanwell et al., 2007). This approach is much more likely to lead to the adoption of such a syllabus by the end-users (teachers and students) since it holds validity by being generated from different perspectives. There is also a greater degree of authenticity through it being grounded in the realities of curriculum construction. This could mean that global core syllabi (Fakoya et al., 2017) may simply be too broad or miss the local clinical context. Therefore, it is likely that several core syllabi may exist for the sometimes-differing contexts found in different countries.

Disparity and agreement between students and staff perspectives

This study brought together the impact and experiences from staff and student perspectives. It is of interest on how there is agreement between staff and students about the importance and

role of a core syllabus. But, the disparity of interest is perhaps in the amount of knowledge that students felt they had at the end of training. There may be several reasons for this. It might be that because CRAS3 had not been in existence when these students were in the early years of the curriculum. Perhaps, it may be that the 156 LOs in the earlier iterations had been covered during medical education but that students had not felt they had retained them, perhaps through insufficient reinforcement. It may be that the 156 LOs are still too many in number and/or are not being taught. This also raises the mismatch between what students perceive as being core and what practicing doctors who were involved in the original Delphi perceive as core knowledge (Smith et al., 2016a). This is echoed in other studies where students perceived the syllabus to be about the 'nuts of bolts' of what they needed and not the detail (Davis and Schrader, 2009). It may be that to help address the mismatch the LOs need to be revisited more frequently during undergraduate and into postgraduate training. Students were not included on the Delphi research panel at the time of the development of CRAS3 and this in future could be undertaken as in other syllabi (palliative medicine) to help create syllabi that are owned as much by students as it is by academics (Kizawa et al., 2012). It is also important that curriculum planners and teachers do not just focus on the content alone and thought must be given to the wider curriculum and how students perceive and experience it (Eberly et al., 2001).

The role of continuing medical education was brought up through examining two perspectives. There is a place for CRAS3 to be used at a wider postgraduate level. This may be in the reflective portfolio when junior doctors can think about the knowledge they are using. There is

also a need for CRAS3 to be further joined up with the postgraduate training of junior doctors. There is a danger that CRAS3 will be modified to cater for postgraduate education, instead it should act as the foundation on which specialist further education is build. This may especially be with the Royal Colleges for certain specialties e.g. surgery and radiology.

Impact of the Core Regional Anatomy Syllabus

What this study has set out to achieve is to examine some aspect of the initial impact of CRAS3 on the learning of anatomy by students and the teaching of anatomy by staff. What is not possible at this stage is to gauge its longer-term impact on the teaching of anatomy to medical students. As pointed out in the introduction, societal impacts of a piece of research or an educational intervention are hard to measure and may only be felt in the longer-term (Bornmann, 2017). There are however some early indications suggesting that longer-term impact might be envisioned. The GMC has replaced CRAS2 by CRAS3 as its reference document for anatomy teaching in the latest edition of Tomorrow's Doctors, therefore recognizing both the value of CRAS3 and the updating that has occurred between CRAS2 and CRAS3.

Bibliographic data are suggestive of a growing interest in CRAS3. A component of impact of CRAS3 had already been determined by its Altmetric Attention Score (ASS). The ASS is a measurement of the attention that research articles receive online. The ASS is based on data from traditional and social media blogs and online reference managers (e.g. Facebook (Facebook Inc., Menlo Park, CA) and Twitter (Twitter Inc., San Francisco, CA). The ASS is influenced by the quantity of posts but also the quality of the source whereby, for example, a

tweet from a doctor followed by other doctors will be weighted higher than an automated tweet from a journal's press office (Altmetric Support, 2017). Using alternative sources of data such as ASS to measure impact increases understanding of the diversity of how the material is being shared, this may be through blogs, tweets and newsletters (Holmberg and Thelwall, 2014, Amath et al., 2017). There has been a rise in the attention given to altmetrics especially in health sciences education (Trueger et al., 2015; Maggio et al., 2017). It is important to understand that CRAS3 may not have been cited by an individual, but it has still informed teachers thinking (Kwok, 2013) as has been shown with CRAS3. Increasing the diversity of dissemination also increases the breath and diversity of individuals who engage in it, often beyond those traditionally classed as academics (Priem et al., 2010). The publication of CRAS3 in the Journal of Anatomy (Smith et al., 2016a) generated to date 2,942 downloads, 24 citations and an ASS of 19 (Altmetric, 2017b). The accompanying methodology paper (Smith et al., 2016b) generated 2154 downloads, 14 citations and an ASS of 11. Both papers are in the top 10% of all research outputs tracked by Altmetric (Altmetric, 2017a). Of course, it is too early to say whether or how this will translate into changes in course design - this is something that will require further long-range studies.

Limitations of the study

It is important to acknowledge that this study was based on perceptions of students and faculty, it presents no evidence to show impact on improving working knowledge or impact on clinical practice. Phase 1 was cross sectional in design and is limited to be a snapshot of student views, rather than an examination of how these views may change over time. The number of

responses was also limited due to possible survey fatigue of students and the fact that the survey was longer due to the need to gather a full data set. There may have been selection bias from students who had particularly enjoyed or not enjoyed anatomy. Data were collected from a single institution, so it must be acknowledged that if a similar study was carried out in other institutions the results may vary due to factors such as curriculum structure. It was not possible to compare the results of Phase 1 to students' examination results and this limits the ability to draw conclusions as to the long-term impact of CRAS3. Phase 2 had a low internal consistency score (0.251), although this may be due to participant numbers. There are only 33 medical schools in the UK and each may only employ perhaps two or three anatomists hence the participation rate of 29 was felt to be representative. Although the findings of this study are based on one local context and may not be generalizable, through using a mixed method approach and situating the data in the context of existing literature it is possible the findings are transferable to other similar contexts. The CRAS3 is also aligned for UK medical teaching. There is yet to be an accepted global core syllabus as there has been in sport and exercise science (Humphries et al., 2018). There also needs to be caution about how far the impact has reached, the examples in this study show change as a result of CRAS3 within the anatomical community but there are limited examples from curriculum planners and policy makers.

CONCLUSION

The core syllabus is a time limited document and as medicine changes it will need to be continuously updated and aligned to changing healthcare needs. This study has shown that CRAS3 has had a direct impact on medical education across the UK. Students at the one

institution felt that they were not proficient in all learning outcomes at the time of graduation. To enable students to feel more confident there needs to be opportunity for students to engage in anatomy in a spiral as it is applied to context. The debate is now less about what do students need to know but about how can the system and educators ensure that the knowledge is not only covered but, in a way, that students can apply and retain it. The revised core syllabus has assisted in developing professional identity and support networks between anatomists. It is important that for core syllabi to be accepted they have to be 'owned' by those who deliver them. The safe application of knowledge is the end goal and the CRAS3 is one small part in a very large machine that brings about this. Beyond this the need is to ensure that the core is suitable and then developed depending on the specialist area of training the doctor enters, effectively streamlining the transition from medical school to post qualifying education.

Core syllabi enable practice to be shared amongst practitioners subjecting course design to peer review, as a means optimize practice. They also help practitioners to defend a particular level of course content within the larger context of a full medical curriculum by providing a level of external validation. In external statutory regulation and validation processes they can provide evidence of coherent course structures. Through their existence they can help to ensure that within a range of curricula design a discipline can be taught coherently, effectively supporting and promoting student learning (Entwistle, 2009). By providing powerful knowledge that enable predictive capacities to develop, they can give graduates confidence as practitioners through deeper understanding of what knowledge is required (Young, 2008).

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LITERATURE CITED

Altman HB. 1989. Syllabus shares “what the teacher wants”. Teach Prof 3:1–2.

Altmetric Support. 2017. About Altmetric and the Altmetric Attention Score. Altmetric, LLP, London, UK. URL: https://help.altmetric.com/support/solutions/articles/6000059309-about-altmetric-and-the-altmetric-attention-score [accessed 12 December 2017].

Altmetric. 2017a. The Anatomical Society core regional anatomy syllabus for undergraduate medicine. Overview of attention for article published in Journal of Anatomy, November 2015. Altmetric, LLP, London, UK. URL: https://wiley.altmetric.com/details/4830443#score [accessed 12 December 2017].

Altmetric. 2017b. Anatomical Society core regional anatomy syllabus for undergraduate medicine: The Delphi process. Overview of attention for article published in Journal of Anatomy, November 2015. Altmetric, LLP, London, UK. URL: https://wiley.altmetric.com/details/4852577#score [accessed 12 December 2017].

Amath A, Ambacher K, Leddy JJ, Wood TJ, Ramnanan CJ. 2017. Comparing alternative and traditional dissemination metrics in medical education. Med Educ 51:935–941.

Bornmann L. 2017. Measuring impact in research evaluations: A thorough discussion of methods for, effects of and problems with impact measurements. High Educ 73:775–787.

Braun V, Clarke V. 2014. Successful Qualitative Research: A Practical Guide for Beginners. 1st Ed. London, UK: SAGE Publications Ltd. 400 p.

Bristol Online Surveys. 2017. The online survey tool designed for academic research, education and public sector organizations. Tower Hill, Bristol, UK. URL: www.onlinesurveys.ac.uk [accessed 17 November 2017].

Bruner JS. 1960. The Process of Education. 1st Ed. Cambridge, MA: Harvard University Press. 128 p.

Burton JL, McDonald S. 2001. Curriculum or syllabus: Which are we reforming? Med Teach 23:187–191.

Connolly SA, Gillingwater TH, Chandler C, Grant AW, Grieg J, Meskell M, Ross MT, Smith CF, Wood AF, Finn GM. 2018. The Anatomical Society's core anatomy syllabus for undergraduate nursing. J Anat 232:721–728.

Creswell JW. 2014. Mixed method procedures. In: Creswell JW. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 4th Ed. Thousand Oaks, CA: SAGE Publications, Inc. p 215–240.

Davis S, Schrader V. 2009. Comparison of syllabi expectations between faculty and students in a baccalaureate nursing program. J Nurs Educ 48:125–131.

Davis CR, Bates AS, Ellis H, Roberts AM. 2014. Human anatomy: Let the students tell us how to teach. Anat Sci Educ 7:262–272.

Drake RL, McBride JM, Lachman N, Pawlina W. 2009. Medical education in the anatomical sciences: The winds of change continue to blow. Anat Sci Educ 2:253–259.

Drake RL, McBride JM, Pawlina W. 2014. An update on the status of anatomical sciences education in United States medical schools. Anat Sci Educ 7:321–325.

Drake RL, Pawlina W. 2014. An addition to the neighborhood: 3D printed anatomy teaching resources. Anat Sci Educ 7:419.

Eberly MB, Newton SE, Wiggins RA. 2001. The syllabus as a tool for student-centered learning. J Gen Educ 50:56–74.

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

Entwistle N. 2009. Teaching for Understanding at University: Deep Approaches and Distinctive Ways of Thinking. 1st Ed. Basingstoke, UK: Palgrave Macmillan. 208 p.

Evans DJ, Watt DJ. 2005. Provision of anatomical teaching in a new British medical school: Getting the right mix. Anat Rec 284B:22–27.

Fakoya FA, Emmanouil-Nikoloussi E, Sharma D, Moxham BJ. 2017. A core syllabus for the teaching of embryology and teratology to medical students. Clin Anat 30:159–167.

Finn GM. 2010. Twelve tips for running a successful body painting teaching session. Med Teach 32:887–890.

Finn GM, Hitch G, Apampa B, Hennessy CM, Smith CF, Gard PR. 2018. The Anatomical Society core anatomy syllabus for pharmacists: Outcomes to create a foundation for practice. J Anat 232:729–738.

Fornaciari CJ, Lund Dean K. 2014. The 21st-century syllabus: From pedagogy to andragogy. J Manag Educ 38:701–723.

GMC. 2018. General Medical Council. General Medical Council, London, UK. URL: https://www.gmc-uk.org [accessed 17 January 2018].

GMC. 2016. General Medical Council. Outcomes for Graduates (Tomorrow's Doctors). 1st Ed. Manchester, UK: General Medical Council. 18 p. URL: https://www.gmc-uk.org/Outcomes_for_graduates_Jul_15_1216.pdf_61408029.pdf [accessed 17 January 2018].

Goodwin H. 2000. Litigation and surgical practice in the UK. Br J Surg 87:977–979.

Google Scholar. 2017. Google Scholar, Google, Inc., Mountain View, CA. URL: https://scholar.google.co.uk [accessed 12 December 2017].

Greenhalgh T, Fahy N. 2014. Research impact in the community-based health sciences: An analysis of 162 case studies from the 2014 UK Research Excellence Framework. BMC Med 15:232.

Griffioen FM, Drukker J, Hoogland PV, Godschalk M. 1999. General plan anatomy objectives of the teaching of anatomy/embryology in medical curricula in the Netherlands. Eur J Morphol 37:228–325.

Hall SR, Stephens JR, Seaby EG, Andrade MG, Lowry AF, Parton WJ, Smith CF, Border S. 2016. Can medical students accurately predict their learning? A study comparing perceived and actual performance in neuroanatomy. Anat Sci Educ 9:488–449.

Heylings DJ. 2002. Anatomy 1999-2000: The curriculum, who teaches it and how? Med Educ 36:702–710.

Holmberg K, Thelwall M. 2014. Disciplinary differences in Twitter scholarly communication. Scientometrics 101:1027–1042.

Humphries D, Jaques R, Dijkstra HP; International Syllabus in Sport and Exercise Medicine Group (ISSEMG). 2018. A Delphi developed syllabus for the medical specialty of sport and exercise medicine. Br J Sports Med 52:490–492.

Jacob H, Fertleman C. 2017. An inclusive approach to developing an undergraduate syllabus. Med Educ 51:537–538.

Javaid MA, Chakraborty S, Cryan JF, Schellekens H, Toulouse A. 2018. Understanding neurophobia: Reasons behind impaired understanding and learning of neuroanatomy in cross-disciplinary healthcare students. Anat Sci Educ 11:81–93.

Jozefowicz RF. 1994. Neurophobia: The fear of neurology among medical students. Arch Neurol 51:328–329.

Kahan SE, Goldman HB, Marengo S, Resnick MI. 2001. Urological medical malpractice. J Urol 165:1638–1642.

Keeney S, Hasson F, McKenna H. 2011. The Delphi Technique in Nursing and Health Research.1st Ed. Oxford, UK: Wiley-Blackwell Publishing. 208 p.

Kidder TM. 2002. Malpractice considerations in endoscopic sinus surgery. Curr Opin Otolaryngol Head Neck Surg 10:14–18.

Kizawa Y, Tsuneto S, Tamba K, Takamiya Y, Morita T, Bito S, Otaki J. 2012. Development of a nationwide consensus syllabus of palliative medicine for undergraduate medical education in Japan: A modified Delphi method. Palliat Med 26:744–752.

Kwok R. 2013. Research impact: Altmetrics make their mark. Nature 500:491–493.

Leonard RJ, Acland RD, Agur A, Blevins CE, Cahill DR, Collins JD, Dalley AF II, Dolph J, Hagedoorn JP, Hoos PC, Jones DG, Mathers LH, McFee R, Mennin SP, Negulesco JA, Nelson ML, Olson TR, Page DW, Pawlina W, Petterborg LJ, Price JM, Spielman JE, Younoszai R. 1996. A clinical

anatomy curriculum for the medical student of the 21st century: Gross anatomy. Clin Anat 9:71–99.

Loddenkemper R, Séverin T, Eiselé JL, Chuchalin A, Donner CF, Di Maria G, Magyar P, Muers M, Muir JF, Nybo B, Phillips G. 2006. HERMES: A European core syllabus in respiratory medicine. Breathe 3:59–69.

Lynn-Macrae AG, Lynn-Macrae RA, Emani J, Kern RC, Conley DB. 2004. Medicolegal analysis of injury during endoscopic sinus surgery. Laryngoscope 114:1492–1495.

Maggio LA, Meyer HS, Artino AR Jr. 2017. Beyond citation rates: A real-time impact analysis of health professions education research using Altmetrics. Acad Med 92:1449–1455.

Mason J. 2002. Qualitative Researching. 2nd Ed. London, UK: SAGE Publications Ltd. 224 p.

McHanwell S, Atkinson M, Davies DC, Dyball R, Morris J, Ockleford C, Parkin I, Standring S, Whiten S, Wilton J. 2007. A core syllabus in anatomy—Adding common sense to need to know. Eur J Anat 11:S3–S18.

McMenamin PG, Quayle MR, McHenry CR, Adams JW. 2014. The production of anatomical teaching resources using three-dimensional (3D) printing technology. Anat Sci Educ 7:479–486.

Moscova M, Bryce DA, Sindhusake D, Young N. 2015. Integration of medical imaging including ultrasound into a new clinical anatomy curriculum. Anat Sci Educ 8:205–220.

Moxham BJ, McHanwell S, Berkovitz B. 2018. The development of a core syllabus for the teaching of oral anatomy, histology, and embryology to dental students via an international 'Delphi panel'. Clin Anat 31:231–249.

Moxham B, McHanwell S, Plaisant O, Pais D. 2015. A core syllabus for the teaching of neuroanatomy to medical students. Clin Anat 28:706–716.

Moxham BJ, Plaisant O, Smith CF, Pawlina W, McHanwell S. 2014. An approach toward the development of core syllabuses for the anatomical sciences. Anat Sci Educ 7:302–311.

Olson DR. 2007. Jerome Bruner: The Cognitive Revolution in Educational Theory. 1st Ed. London, UK: Continuum International Publishing Group. 224 p.

Parkes J, Harris MB. 2002. The purposes of a syllabus. Coll Teach 50:55–61.

Phillips AW, Eason H, Straus CM. 2018. Student and recent graduate perspectives on radiological imaging instruction during basic anatomy courses. Anat Sci Educ 11:25–31.

Priem J, Costello KL. 2010. How and why scholars cite on Twitter. Proc Assoc Inform Sci Tech 47:1–4.

Prince KJ, Scherpbier AJ, van Mameren H, Drukker J, van der Vleuten CP. 2005. Do students have sufficient knowledge of clinical anatomy? Med Educ 39:326–332.

Rumore MM. 2016. The course syllabus: Legal contract or operator's manual? Am J Pharm Educ 80:177.

Smith CF, Finn GM, Stewart J, Atkinson MA, Davies DC, Dyball R, Morris J, Ockleford C, Parkin I, Standring S, Whiten S, Wilton J, McHanwell S. 2016b. The Anatomical Society core regional anatomy syllabus for undergraduate medicine. J Anat 228:15–23.

Smith CF, Finn GM, Stewart J, McHanwell S. 2016a. Anatomical Society core regional anatomy syllabus for undergraduate medicine: The Delphi process. J Anat 228:2–14.

Smith CF, Mathias H. 2007. An investigation into medical students' approaches to anatomy learning in a systems-based prosection course. Clin Anat 20:843–848.

Smith CF, Mathias HS. 2010. Medical students' approaches to learning anatomy: Students' experiences and relations to the learning environment. Clin Anat 23:106–114.

Smith CF, Mathias HS. 2011. What impact does anatomy education have on clinical practice? Clin Anat 24:113–120.

Smith CF, Tollemache N, Covill D, Johnston M. 2018. Take away body parts! An investigation into the use of 3D-printed anatomical models in undergraduate anatomy education. Anat Sci Educ 11:44–53.

So S, Patel RM, Orebaugh SL. 2017. Ultrasound imaging in medical student education: Impact on learning anatomy and physical diagnosis. Anat Sci Educ 10:176–189.

Thompson B. 2007. The syllabus as a communication document: Constructing and presenting the syllabus. Comm Educ 56:54–71.

Trueger NS, Thoma B, Hsu CH, Sullivan D, Peters L, Lin M. 2015. The altmetric score: A new measure for article-level dissemination and impact. Ann Emerg Med 66:549–553.

Tubb RS, Sorenson EP, Sharma A, Benninger B, Norton N, Loukas M, Moxham BJ. 2014. The development of a core syllabus for the teaching of head and neck anatomy to medical students. Clin Anat 27:321–330.

Tubbs RS, Paulk PB. 2015. Essential anatomy of the head and neck: The complete Delphi panel list. Clin Anat 28:423.

Turney BW. 2007. Anatomy in a modern medical curriculum. Ann R Coll Surg Engl 89:104–107.

Young MFD. 2008. Bringing Knowledge Back In: From Social Constructivism to Social Realism in the Sociology of Education. 1st Ed. Abingdon, Oxon, UK: Routledge. 272 p.

TABLES:

Table 1. Questions to Students.

Question	
1.	Of the Learning outcomes you have just evaluated, what proportion of them do you think you know? (as a percentage, e.g. 70%)
2.	Do you think that there are any areas in the Brighton and Sussex Medical School curriculum that are currently being over taught or under taught? Please state specific areas.
3.	Do you think your anatomy knowledge in any of the following areas is deficient? (please tick) (Anatomical terms, Head and neck, Vertebral column, Thorax, Upper limb, Abdomen, Pelvis and perineum, Lower limb)
4.	If you have ticked any of the above, why do you think this is?
5.	What could be done to further support you in your anatomy?
6.	What is the best way you learn anatomy?

Table 2. Perceived deficiencies in knowledge by students.

	Number of students (absolute) who perceive their knowledge is deficient in regions of the Core Regional Anatomy Syllabus			
Region of syllabus	Year 3 (n %)	Year 4 (n %)	Year 5 (n %)	Overall (n %)
Anatomical terms	7 (5)	2 (2)	1 (<1)	10 (6)
Head and neck	41 (30)	30 (25)	18 (14)	90 (55)
Vertebral column	24 (18)	16 (13)	7 (5)	48 (29)
Thorax	10 (7)	6 (5)	1 (<1)	17 (10)
Upper Limb	22 (16)	15 (13)	8 (6)	46 (28)
Abdomen	11 (8)	6 (13)	0 (0)	17 (10)
Pelvis and perineum	38 (28)	20 (17)	11 (8)	69 (42)
Lower limb	30 (22)	16 (13)	11 (8)	58 (35)
No areas deficient	14 (10)	11 (9)	17 (13)	42 (25)

Table 3. Survey to Anatomists.

1. Institution/Job Role
2. Are you aware of the new core anatomy syllabus for undergraduate medical students?
3. How did you find out about the new syllabus?
4. How do you teach anatomy?
5. Have you checked the anatomy syllabus at your own institution against the new syllabus?
6. Have you shared the new syllabus with colleagues?

7. Have you shared the new syllabus with students?
8. Have you changed any teaching as a result of the new syllabus, please state which areas of the body and how.
9. Are there Learning Outcomes (if so which) that are missing from the core syllabus?
10. Are there areas (if so which) of your curriculum that are over-taught compared to the syllabus?
11. Are there areas (if so which) of your curriculum that are under-taught compared to the syllabus?
12. Which body region in the core syllabus do you feel requires the greatest amount teaching time and why?
13. Without constraints, where in medicine should the core syllabus be delivered?
14. What resources do you feel you need to deliver better anatomical education?
15. How has the new syllabus generated conversation/debate within your network?
16. Which core syllabus would you like the Anatomical Society to produce next?
17. Please provide any furthers comments, if you would like to be contacted to participate further in any subsequent discussions please provide your email address.

Table 4. Summary of Results of Survey to Anatomists.

Question	Result (n %)
1.	Professor/Head of Anatomy 16 (32) Associate Professor / Senior Lecturer 10 (20) Assistant Professor/ Lecturer 14 (28) Not provided 10 (20)
2.	50 (100)
3.	Professional Body 18, (36) Internet 4 (8) Word of Mouth/Personal Contact 12 (24) Journal of Anatomy publication 4 (8) Not provided 12 (24)
4.	Prosection 11 (22) Dissection 3 (6) Both 30 (60)
5.	Yes 24 (48)
6.	Yes 32 (64)
7.	Yes 17 (34)
8.	Yes 23 (46)

Legends

Figure 1. Perceived relevance of learning outcome per body region as judged by students. Students were asked to rank each learning outcome in the Core Regional Anatomy Syllabus on a Likert scale: essential, important, acceptable or not required. Learning outcomes in the Head and Neck had the lowest amount of items ranked as 'essential'.

Figure 2. Perceived relevance of learning outcome by year group. The percentage responses are categorized to show the difference in perception between year three, four and five medical students. Year five students perceived a higher proportion as essential.

Figure 3. Percentage of learning outcome in Core Regional Anatomy Syllabus that students estimate they know by year of study. No student in any year reported knowing 100% of the learning outcomes.