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Warwick Medical School: A four dimensional curriculum

Abstract (max 250 words)

Medical Curricula vary hugely across the world. Notions of horizontal and vertical integration and spiral curricula are present in many modern curricula although true integration happens to a varying degree.

By seeing the development of a curriculum as fundamentally about integration, rather than as a process of seeking to integrate separate elements, we have developed a programme that prepares students well for complexities of and change in practice. The risks inherent in bringing forward the point at which learners need to deal with such substantive and fundamental complexity produces challenges. Such challenges are ones that our students have shown they can not only deal with, they are often better equipped than faculty to provide solutions for themselves, their peers and those who follow them.

We present the three dimensions of integration in the Warwick Medical School curriculum and note the fourth dimension provided by our students, being student led teaching and support far beyond what is normally found in medical courses.

Introduction

Many modern medical curricula combine material from separate medical disciplines using *horizontal integration*. Initial examples encompassed moving from the study of scientific disciplines such as anatomy and physiology to all aspects of a given organ system such as the liver (Harden, Sowden, & Dunn, 1984). More recently, clinical horizontal integration includes learning about rheumatological diseases alongside orthopaedic conditions from teaching about musculoskeletal problems. (Brauer & Ferguson, 2015) When designing a curriculum, such integration is often achieved using problem- or presentation-based learning, for example using back pain as a focus that integrates both rheumatological and orthopaedic causes, as well as the possibility of other causes such as infectious, surgical, vascular or psychological. This clinical horizontal integration is intended to make learning more practice-focused, encouraging students to consider clinical presentations or problems rather than just specific diseases that may be organised into somewhat arbitrary, often historically-determined silos of specialty practice.

Medical curricula have also used *vertical integration* to blend learning of basic sciences with clinical practice, breaking down the classical pre-clinical/clinical divide so that, for example, clinical examination is learnt alongside anatomy and uses surgical or orthopaedic disease to contextualise the acquisition of anatomical knowledge and clinical skills (Dahle, Brynhildsen, Behrbohm Fallsberg, & Rundquist, 2009) From a curriculum design perspective, this often results in the development of themes that vertically cross-cut modules or blocks, so that topics such as physiology or professionalism are not taught as isolated subjects but rather integrated into a clinical context where they can be practically applied by students. This has most often been used to bring forward clinical exposure to enthuse students and provide clinical context to their learning. It can also be used to ensure that students revisit basic scientific and professional principles whilst learning more advanced skills such as clinical leadership or managing complex patients with multiple comorbidities, a key feature in graduating students who are scholars and scientists (Rees, Dangerfield, Katz, & Schofield, 2015) who continue to think in terms of the scientific underpinnings of disease rather than simply learning them as a passport to enter clinical medicine.

Adopting a spiral curriculum (Harden & Stamper, 1999), where learning on a topic is returned to on a number of occasions at higher levels, has been used as a means to developing both deeper learning in students and providing appropriate levels of scaffolding for students to build up to more complex cognitive constructs.

We describe how at Warwick Medical School we have developed a three-dimensional curriculum design that combines the benefits (and some of the challenges) of horizontal, vertical and spiral integration (Brauer & Ferguson, 2015). As this curriculum has been implemented, a fourth dimension has appeared; the engagement of students with an extensive peer teaching programme. Students use innovative teaching methods to consolidate core knowledge and support fellow students in areas which they find challenging.

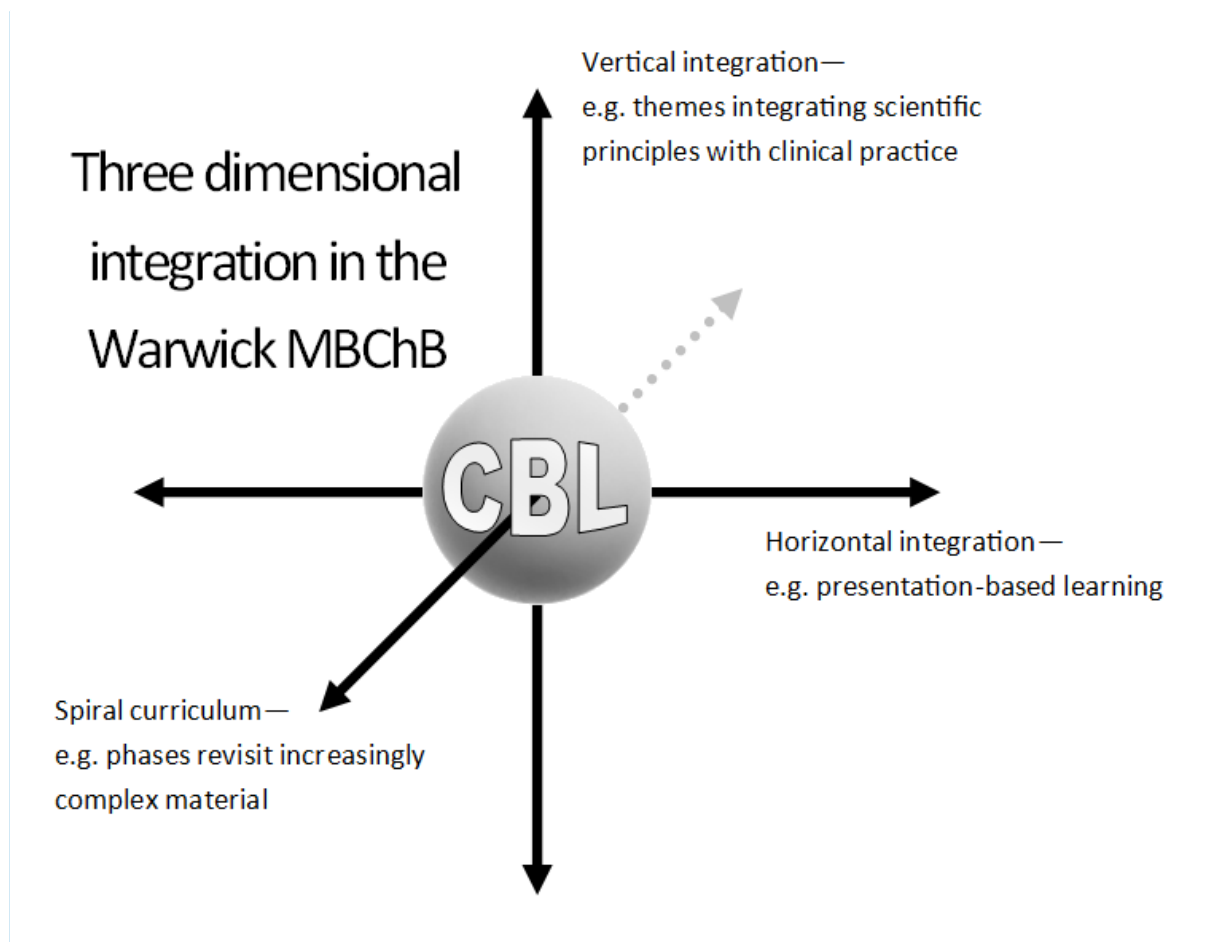
The MBChB curriculum at Warwick Medical School

Warwick Medical School is a well-established four year accelerated Graduate Entry (GEM) medical school, established in 2000 in conjunction with Leicester Medical School and becoming a school in its own right in 2007. Development of a new curriculum commenced in 2010 with introduction to students entering in autumn 2013. The key aims of the curriculum review were to further integrate and improve the clinical relevance of learning, to enhance student self-selection and to support transition of learners moving to new learning environments and types of learning both on entry, during and at the end of the course. Key to this was extensive use of Case Based Learning (CBL) throughout the course. (Thistlethwaite et al., 2012) The curriculum comprises three distinct phases: phase 1, foundations of science and medicine, Phase 2 principles of clinical practice and phase 3, preparation for foundation training.

https://warwick.ac.uk/fac/med/study/ugr/courseinfo/structure/mb_chb_curriculum_map-sept_2017_web.pdf

Three dimensional integration

At Warwick Medical School, we feel we have successfully created 'three-dimensional integration'. Our curriculum model combines *horizontal* and *vertical integration* with the natural *spiralling* of increasing complexity that exposes students to material that builds incrementally as the course progresses. Of key additional note, however, the integration is not simply structural, in a way that can be represented on a classical diagram. Learning is provided in horizontally integrated **blocks** (such as system-based, 'blood, lungs and heart'), vertically integrated clinical scientific learning overseen by a **theme** lead and team (such as cell and tissue biomedicine) and returned to in a **spiral** manner in each phase.



[DCP1]

Each phase includes content mapped across the breadth of medical practice, essentially covering all areas of medicine at least three times. Using the example of Child Health, Phase I students complete a block entitled 'Reproduction and Child Health', where they are introduced to concepts such as paediatric growth, development and physiology. As students move into Phase II, they learn to interact with children in both community and hospital settings and begin to assess, diagnose and manage children presenting with common conditions. In Phase III, students undertake several specialist clinical placements that involve caring for children, most specifically a six-week block entitled Child Health, but also in other blocks such as General Practice, Musculoskeletal Healthcare and Psychiatry. This phase structure enables students to gain a broad understanding of both theoretical and practical aspects of a subject at an early stage, revisiting and developing their understanding and skills at later stages in the curriculum. This is a good example of 'spiralling', where key concepts are built upon and consolidated in increasingly complex ways as the curriculum progresses.

Horizontal integration is achieved by designing the whole curriculum around core clinical presentations rather than disease processes, an approach that challenges students to habitually consider diagnostic method, fostering a problem-solving approach using their understanding of underlying pathophysiology. Students become accustomed to considering all aspects of healthcare in every clinical encounter, engendering a holistic patient-centred approach to illness.

Vertical integration is achieved by our seven theme leads, whose responsibility it is to blend their theme into both classroom and clinical learning in all phases of the curriculum. In addition to facilitating clinical case-based learning, CBL also facilitates vertical integration as it incorporates such

theme-related material, encouraging students to consider it directly alongside the more clinical aspects of medicine. This has allowed students to encounter theme-related material in a wide variety of clinical contexts, in addition to the more traditional lectures and group work. We feel this provides a more realistic and practically useful method of teaching and learning some of the more nebulous or complex concepts contained within themes such as professionalism or ethics.

Case-based learning: a focus for integration

At the heart of integration in each dimension is the focus on case-based learning (CBL) through all phases of the curriculum. Whilst it is well recognised that contextualising basic science learning into clinical cases is advantageous to learning (Bowe, Voss, & Aretz, 2009) we use CBL cases later in the curriculum to continue to develop learning in biological and social sciences. An innovative and collaborative approach to case development ensures that block, theme, clinical and professional material is mapped onto every case. Each case has two core case-writers (usually one from primary and one from secondary care), and in addition has input from the leads of each of our seven themes.

In order to illustrate the integrative value of CBL, Figure 1 shows how students explore the topic of heart failure through learning from the cases of Jim, Bob and James.

Figure 1: Three cases involving heart failure

Phase 1 case learning areas: "Jim"

- Functional histology of the heart
- Jim's view of normality and its impact on outcome
- Communication and Shared-Decision Making
- The cardiac cycle
- Cardiac output and cardiac muscle
- Haemostasis
- Oedema
- Cardiac history
- Cardiac examination
- Screening for coagulation abnormalities
- Pathophysiological, clinical and Radiological correlation.
- Pathophysiology of cardiac failure
- Referral for further assessment
- Basic investigation of cardiac disease: Echocardiography
- Treatment of Heart failure
- Follow up: The importance of collegial and Interprofessional working
- Communication: discussion of prognosis and Advanced care planning
- Referral letter exercise

Phase 2 case learning areas: "Bob"

- Complications of hypertension
- Pathophysiology of angina
- Diagnosis of angina
- Clinical features of heart failure
- Clinical assessment of affect
- Polypharmacy
- Concordance

- Mechanism of action of nitrates
- IHD: Risk factors for atherosclerosis
- Referred pain
- Clinical signs of heart failure
- Chronic kidney disease
- Patterns of anaemia
- Hypercholesterolaemia
- Mechanism of action of loop diuretics
- Interprofessional Working: Community
- Mental state examination:
 - affect, speech, thought process, thought content
- Nutritional status
- Advance Care Planning
- Assessment and risk factors for depression
- Nutrition and frailty
- Mechanism of action of selective serotonin re-uptake inhibitors

Phase 3 case learning areas: “James”

- Pneumonia;
 - Different types of pneumonia (e.g. community acquired, healthcare associated, aspiration) - Severity classification, Microbiological basis, Antibiotic therapy.
- Sepsis and classifications of sepsis, Management of sepsis
- Chronic kidney disease and long term management including dialysis
- Pulmonary oedema – identification, management
- Indications for emergency dialysis
- Medical error - Duty of candour
- Communication skills with regards to breaking bad news

Core clinical education: an integrated transition to clinical practice

Perhaps the most innovative element of our integrated curriculum is the first full time clinical attachment, a 30-week block, ‘Core Clinical Education (CCE)’. In CCE, students are allocated to three 10-week clinical placements that combine experience in both community and hospital settings. Each student is allocated to a faculty team, incorporating a wide variety of clinicians from across the core branches of medicine, whose role is to facilitate the student’s learning in their specific clinical context. In the first 10 weeks, students are required to develop their history and examination skills in the specific clinical context provided by their faculty team. For example, they may be assessing a pregnant woman in an antenatal clinic on one day and examining a patient with a fracture the next day, but the focus throughout is on history and examination. In the second 10 weeks, students focus on formulating differential diagnoses and rational use of investigations in a series of different clinical contexts. In the third 10 weeks, students begin to formulate a variety of approaches to management of common clinical presentations. Each 10 weeks is with a different faculty team, providing three varied combinations of clinical contexts, covering the breadth of clinical medicine over 30 weeks.

Phase II MBChB (Year 2) at Warwick Medical School



Instead of emphasising the clinical specialism in which the student is learning, CCE focuses both students and faculty on the more important core skills required of all doctors, such as clinical assessment, problem solving and management. Therefore, even within CCE, students may revisit more common clinical topic areas on several occasions, experience them in a variety of different clinical contexts, care locations and with different educational focus. For example, they may encounter a patient with chest pain who presents to their GP or hospital during CCE1, where the educational focus would be on taking a history and examining a patient with chest pain. In CCE2, they are likely to encounter similar patients in primary and secondary care, but in this block the focus is more on formulating a differential diagnosis and the rational use of investigations so students would focus more on attending a cardiology or respiratory clinic, or observation in the radiology department. In CCE3, where the focus is more about principles of management, students would experience the approaches used to manage chest pain in primary and secondary care, learning principles such as pharmacological approaches such as pain relief, as well as non-pharmacological principles such as self-care, management of psychological symptoms and procedural/'surgical' approaches such as angioplasty. Throughout all of this, students and faculty are using an opportunistic approach to learning that, whilst ensuring core clinical presentations are being studied, allows them to make the most of clinical learning opportunities as they arise to learn about the broader principles of clinical medicine, rather than specific silos of specialist care.

Throughout CCE, students learn in a wide variety of settings throughout primary and secondary care that change from one day to the next but are always coordinated and supported by their local faculty team of clinicians. As an example, in any given week students may attend a gastroenterology clinic, a labour ward shift, an elderly care ward round, a fracture clinic, the emergency department, shadow a district nurse, observe aortic aneurysm screening in the community and visit a nursing home with a GP. Although often daunting to begin with, this approach allows students to feel confident learning in a wide variety of clinical settings so that the next time they enter labour ward or a general practice they can make the most of the learning opportunities available to them, reducing the contextual cognitive burden during subsequent placements.

Integration in clinical placements

Integration is also designed into phase 3 clinical blocks that include both community and hospital placements and which integrate learning across different specialties, further promoting a whole-person approach to medicine. For example, our "Care of the Surgical Patient" block combines experience in surgery with anaesthesia encouraging consideration of surgical disease from a patient

perspective rather than purely from the surgeon's and the "Musculoskeletal" block which includes rheumatology, neurology and orthopaedics.

Developing vertically cross-cutting themes also brings the benefits of having nominated champions for each theme, who can consider imaginative and novel ways of engaging students with their theme material at different stages of the curriculum, and liaising with the appropriate block leads to accomplish this. In later phases of the curriculum, where learning is mainly in a clinical setting, theme leaders continue to champion their themes to incorporate, for example, small group ethics discussions in the Obstetrics & Gynaecology and GP blocks based on real cases and facilitated by a University ethicist. As well as allowing students to fully contextualise their learning alongside contemporaneous clinical experience, it also creates a faculty of educators who work together as a team, linking our university-based teachers with those training our students in clinical settings.

Benefits of an integrated curriculum

The prime role of UK medical schools is to support the development of a future workforce ready to fulfil the requirements of the UK National Health Service (NHS) and we believe our curriculum is well placed to do this. This includes a focus on key areas of need, currently around primary care, mental health care in a variety of clinical contexts and the need to train for work with an aging population.

Integration of mental health alongside physical health problems in CBL cases from phase 1 onwards supports the development of a holistic approach and interest in mental health issues in addition to careers in psychiatry. Most CBL cases also include a primary care element which is presented in a positive way, promoting general practice as a positive career choice as suggested by Wass. (Wass, Gregory, & Petty-Saphon, 2016) A good proportion of Warwick graduates continue to enter specialist training in these underserved specialities compared to other schools (GMC, 2017). From phase 2 onwards many cases focus on patients with multiple co-morbidities and frailty, within a social, societal and family context, who require an integrated and collaborative approach to their care and represent the types of patients that graduates will be predominantly caring for in foundation training and beyond.

Pedagogically we feel that such an innovative curriculum stimulates students to habitually assess and treat people, rather than specific diseases, bridging gaps between silos of medical specialism to produce holistic patient-centred doctors who are best placed to overcome challenges such as multi-morbidity within the rapidly-changing face of modern medicine.

Peer teaching- a fourth dimension

Teaching is a core skill for doctors, whether educating a patient about their illness or teaching junior doctors or students from medical or other courses in all clinical settings. Teaching development has therefore been identified by the GMC as key for medical students. (GMC, 2015). Whilst some schools have included peer assisted learning into their curricula (Jackson & Evans, 2012; Nelson et al., 2013), Warwick Medical School has a keen student population who have developed their own peer teaching projects to help their colleagues and develop their own skills. The number of initiatives has grown over the last 10 years and now include interactive PowerPoint (©Microsoft Inc, USA) [mc2]-free teaching sessions (Keith & Owen, 2017), speciality specific courses led by speciality focused student societies, a course on 'how to teach', bedside teaching and most recently a full mock OSCE exam. Peer teaching enables students to focus on areas they find difficult, gain additional exam

experience, learn about topics not available in the main curriculum and develop new practical skills (Yu et al., 2011). Meanwhile peer tutors gain benefits by developing a deeper understanding of subjects and having the opportunity to practise and refine their teaching skills. The standard of teaching students have developed has been such that they have been invited to deliver workshops on interactive teaching to medical school staff and across the wider university.

Initially peer teaching involved 2nd years teaching 1st years, however with the added cognitive burden on students of integrated learning in CCE where they often felt “thrown in at the deep end” peer teaching of 3rd years to 2nd years developed. Through cognitive and social congruence (Lockspeiser, O’Sullivan, Teherani, & Muller, 2008), student teachers have addressed the particular needs CCE students have in judging depth of learning required in the context of increased initial anxiety associated with integrated learning. The number of students now engaged with peer learning and the high regard in which they hold it, are such that it is considered to be very much part of the Warwick experience.

Lessons learned

Careful and timely faculty development with clinician partners is essential to the introduction of a curriculum where students are accessing many different learning areas within a clinical placement. As students’ learning crosses the departmental and specialty divisions in modern healthcare, some clinical staff found the concept of a student not being placed with their team alone difficult to adapt to, being a frame shift from their own training. Frequent reiteration of the principles and practice of the refreshed curriculum were necessary over a number of years to regain the level of faculty engagement prior to the change.

Students also struggled with managing multiple learning opportunities within one placement, particularly at the beginning of CCE, a phenomenon well recognised in integrated curricula (Walters et al., 2012). A tension existed between the desire to be part of a clinical team, or community of practice, and to cover the wide range of necessary learning outcomes. Increased scaffolding (Vygotsky, 1978) was provided to support students through this challenging initial phase, although for the first cohort of the refreshed curriculum with no students with prior experience to provide reassurance, this resulted in considerable anxiety and affected NSS results (HEFCE, 2017), although outcomes at final exams were as least as good as previously suggesting no academic detriment.

When integration is complete, it is hard to codify learning outcomes in the classical way. Cases are likely to address outcomes for both that phase of the course, and for prior and indeed later phases, in a way where the learning is both about physiology, population perspectives and professional aspects of care. Whilst authentically reflecting the level of complexity within which doctors work, it is harder to describe in terms of a classical assessment blueprint and in a way which mirrors the sort of outcome-specific learning and assessment advice that learners are increasingly used to from schools and from other degrees. In this way, both the curriculum mapping and assessment blueprinting had to become three-dimensional rather than a more traditional linear or two-dimensional approach.

Practice points

- Curricular integration can help promote careers in under-recruited workforce specialties
- Complex curricula require investment in faculty development
- Introduction of complex curricula require intensive communication to students, additional support and may impact student satisfaction

- Peer learning is highly regarded by students and can provide essential support in complex curricula

Disclosure statement.

Dr Paul de Cates had the initial idea for the paper which was then largely written by himself and Dr Kate Owen, with all three authors developing, reviewing and approving the text. All three were involved in the development of the new Warwick Curriculum and therefore are committed to the philosophy of this approach.

Notes on contributors which should be a short biographical note for each author

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