MEDICAL SCIENCE EDUCATOR
The Journal of the International Association of Medical Science Educators
Med Sci Educ 2012; 22(3S): 185-189

COMMENTARY

"The Graduate as Scientist and Scholar": Building a Curriculum Suitable for All

Shelby S. Webster[1], Kevin P. Shotliff[1,2] & Lisa Burton[2]
[1]Chelsea and Westminster Hospital NHS Foundation Trust, London, UK
[2]Imperial College London, London, UK

The need to encourage and nurture young medical minds in research is being increasingly recognized in the face of declining research activity among clinicians.[1-5] In the United Kingdom (UK), the Walport Report made recommendations in 2005 to address the "perilous state of academic medicine and dentistry in the UK".[6] These recommendations included new integrated academic pathways for postgraduate trainees; and a need to facilitate students' understanding of "the attractions of a career in academic medicine and to be taught by clinical academics".

This commentary aims to review the current state of play in undergraduate medical research education in the UK; then proposes a step wise approach to curriculum review to achieve research literate and competent medical graduates.[7] It is our purpose that "scientific research" will encompass all modalities of medical research that follow the rigorous and systematic approach of scientific inquiry.

Undergraduate medical curricula in the UK have been transformed over the last 20 years driven partly by the General Medical Council (GMC) guidance "Tomorrow's Doctors".[1] Now in its third edition, its foreword states "For this edition, among a number of important changes, we have responded specifically to concerns about scientific education". The GMC lays out objectives relating to "The Doctor as a Scholar and a Scientist" (Table 1).

There is an understanding that doctors at all stages of their professional career should have an understanding, appreciation and awareness of research activity in their field of practice and in their institution.[6] Furthermore, there is a relationship between acquisition of research skills as an undergraduate and postgraduate research activity.[8]

GMC undergraduate curriculum objectives relating to knowledge and application of scientific research
1. Critically appraise the results of relevant diagnostic, prognostic and treatment trials and other qualitative and quantitative studies as reported in the medical and scientific literature.
2. Formulate simple relevant research questions in biomedical science, psychosocial science or population science, and design appropriate studies or experiments to address the questions.
3. Apply findings from the literature to answer questions raised by specific clinical problems.
4. Understand the ethical and governance issues involved in medical research

Table 1. *Learning outcomes for "The Graduate as Scientist and Scholar".[1]*

What are the current problems with research skills teaching in UK undergraduate medical curricula?

While we recognize other contributory factors in the provision of research skills teaching (such as unwieldy approval processes for student led research projects), we argue that an important consideration in research skills teaching is curriculum design and evaluation.[9-11]

Medical undergraduate curricula in the UK are currently composed of a core curriculum and selected student components (SSCs).[1, 2] SSCs allow students to explore an area of interest in greater depth, or to study an area not included in the core curriculum. SSCs can offer important assessable

Corresponding author: Shelby S. Webster, MA BMBCh MRCP PGC Medical Education, Department of Medical Education, Chelsea and Westminster Hospital NHS Foundation Trust, 369 Fulham Road, London, SW10 9NH, UK Tel: +44-20-3315 -5258, Email: shelbywebster@doctors.org.uk

learning outcomes relating to research methodology, information gathering and data processing.[2,13] Alternatively, research skills may be learned during an intercalated or integrated degree (for example, BA, BSc, BMedSci, MSc). However, the proportion of students studying for these degrees can vary significantly between schools.[2,12] Also, the impact of tuition fees (in England) on students' decision to lengthen their duration of study to obtain a higher degree is not yet known. As a result, "the SSC program in some schools may provide the only or predominant opportunity for fuller grounding and practical consolidation of research skills for many students".[2] The variable and inconsistent nature of outcome mapping and assessment of learned outcomes in SSCs currently, does not assure that every student achieves competency in investigative and research methodology and skills as laid out by the GMC.[1]

How can we develop our undergraduate medical curriculum to better achieve scientific research outcomes for our students?

In order to fully integrate research skills into the undergraduate curriculum to achieve assessable outcomes for all our students, the authors propose a curriculum design using Harden's 10 step framework (Table 2).[7]

1.	What are the needs in relation to the product of the training programme?
2.	What are the aims and objectives?
3.	What content should be included?
4.	How should the content be organised?
5.	What educational strategies should be adopted?
6.	What teaching methods should be used?
7.	What educational environment should be fostered?
8.	How should the process be managed?
9.	How should assessment be carried out?
10.	How should details of the curriculum be communicated?

Table 2. *Harden's questions to consider when developing a curriculum.*[7]

The needs in relation to scientific research skills by graduate doctors are laid out in the UK by the GMC's "Tomorrow's Doctors" (Table 1).[1] Any curriculum change or development by a UK medical school should consider these needs as essential. Schools wishing to consider additional needs for their students might consult local senior researchers, researchers actively involved on their teaching faculty and feedback from recent graduates on what aspects of their research skills teaching were lacking or inconsistent.[13] The Delphi technique has been used successfully to identify competencies or outcomes for curriculum planners in medicine and other fields. This technique involves collecting opinions independently from a panel of experts, then collating and providing feedback for consecutive rounds until group consensus is reached.[13,14]

The aims and objectives of the course should reflect the needs identified by the GMC and any other additional needs analysis method such as those described above. The higher order objectives may vary between schools. For example, some medical schools offer integrated BSc degrees, many of them research oriented, to all their medical students, thus providing the opportunity for students to achieve higher level competency in research focused outcomes.

The content that is to be taught and learnt should map carefully the overall aims and objectives described above. The content should integrate specific research skills such as performing a systematic literature search and critically appraising scientific papers with generic competences such as team building, written and verbal communication skills, and core professional values such as integrity, honesty, and resilience. Content should be relevant to all students: the importance of appraisal of evidence, with subsequent translation and application into high quality patient care should be emphasized through practical examples.

How the content is organized is crucial and should provide integration and interdisciplinary learning. Where a curriculum depends on SSCs for research exposure and achievement of core competences, there must be assurance that every student selects an appropriate mix of SSCs. This may be achieved by one SSC block having only research type activities from which to choose. Alternatively, "research awareness" skills could be taught as part of the core curriculum and then integrated during other parts of the curriculum. A curriculum map is helpful to illustrate the relationship between content. Horizontal and vertical integration of content creates the classic spiral curriculum.[15]

The strategies to be adopted when implementing research skills into the undergraduate curriculum should consider the local teaching expertise, resources and best evidence medical education. Harden proposed the SPICES model as an instrument for curriculum developers to analyze and develop curricular strategy.[16] The model describes six curriculum issues as a spectrum with the most innovative at one extreme and the most traditional at the other. The issues include student-centered vs. teacher-centered teaching (S); problem based learning vs. information gathering (P); integrated vs. discipline based curricula (I); community-based vs. hospital-based training (C); elective vs. standard courses (E); and systematic vs. apprenticeship oriented learning (S). Student-centered learning is now accepted as encouraging a deeper approach to learning.[17] Students more accustomed to teacher-centered methods may find this type of learning more difficult but the benefits for future lifelong learning merit its perseverance.[18] Problem-based or team-based learning allow integration of clinical knowledge with information gathering and allows generic skills to be practiced and develop. Research skills can be equally applied and learnt in the community and in hospital settings (depending on local expertise).[5] Academic educators should not be overlooked as sources for academic tutors and may often be community based.

The attainment of outcomes laid out by the GMC should be core objectives for all medical students. Where these learning outcomes may not be met by a school's core curriculum, there should be provision and assurance that they will be met during at least one of the SSCs. Additional elective or student selected options to gain more research experience may be available either in the form of an integrated degree such a BSc; or within a student selected component.

Teaching methods should adopt current theories of best practice in medical education.[19,20] Active, reflective learning in small groups may give students maximum opportunity to practice and become involved in their learning. Regular formative self-assessment should be encouraged. The use of e-learning modules and electronic resources could help provide guidance to relevant papers suitable for appraisal. Opportunities to visit, meet and interact with different types of medical researchers, such as the basic science researcher and the hospital or community based translational researcher will allow students to develop different perspectives of medical research. Also, the benefits of a skilled research mentor has been noted by several authors.[3,21] This correlates with other evidence from the medical literature on the benefit of mentoring for professional development.[22,23]
An appropriate educational environment is important. This should be an environment focused on student learning in a non-judgmental and supportive manner. Critical appraisal and awareness skills may take place in the classroom setting while more research active skills may take place more appropriately in a laboratory, ward or library setting. Likewise, we need a supportive faculty environment with clear, commonly understood goals, participative leadership, excellent communication and appropriate access to funding and resources.[24]

Management of medical undergraduate curricula in the UK is currently done locally by University Medical School educational departments. The management processes are, in turn, quality assured by the GMC. The overseeing role of the GMC extends into postgraduate medical education allowing continuity and cohesiveness.[25] This arrangement has the advantage of individual schools designing their curricula to optimize local teaching expertise and to respond to students' feedback at a local level. An appropriate mix of academic and clinical staff should sit on organizing committees to ensure fair representation of content and teaching emphasis. The potential drawback of curriculum variation is that each medical school must have the expertise and staff to continually develop and improve their own dynamic curriculum; with the almost inevitable result that similar work is repeated across different centers. Some medical schools in the UK have realized that collaboration for mutual goals would be both time- and resource-efficient, and have formed consortia to examine, evaluate and develop educational strategies.[12]

Assessment of outcomes relating to research knowledge, skills and attitudes should include a variety of methods including those primarily testing knowledge acquisition and those testing skills and attitudes. Currently, critical appraisal skills taught during the core curriculum may be inconsistent and not assessed.[2] The scientific research outcomes in SSCs are again inconsistent and often not assessed.[2] The Objective Structured Clinical Examination (OSCE) assessment method has been shown to have very good construct validity and inter-rater reliability when designed to assess critical appraisal skills and broader evidence based practice skills.[26,27] Other assessment modalities such as 360 degree feedback and self-assessment tools are helpful in assessing higher performance levels and for assessing attitudes and professional behavior in a

team environment.[28] Students' portfolios can be useful learning and assessment aids to provide individualized content mapping of core and student selected components. Portfolios can also demonstrate horizontal and vertical integration of skills learnt and provide evidence of the level of achievement attained.[2] This may introduce an element of student self-assessment which, if supported by a research skills mentor could provide a robust and reliable assessment method.[29,30]

Communication of curriculum changes and development are important to avoid resistance to change and to create a united community for implementation. Key stakeholders in the curriculum should be advised of the proposed changes including managers, clinical and scientific leads, and all teaching faculty. A strong organizational culture "ensures everyone is on the same boat and that they know where the boat is headed".[31] Current and prospective students should also be kept well informed of the proposed plans, timing and method for implementation. The reasons supporting the change and potential drawbacks and how they will be overcome will have to be addressed. A concept map of the current and new curriculum illustrating how and when the knowledge and skills will be taught and assessed is often a valuable tool. Opportunity for stakeholders to ask questions throughout the planning and implementation stages is vital and involving representatives of key stakeholder groups in the organization of the change would give them a degree of ownership and reduce skepticism and resistance.[32]

In conclusion, medical undergraduates in the UK are expected to be research literate and aware by graduation. With careful, rigorous and systematic curriculum evaluation, this can be achieved allowing high quality research and best evidence patient care to thrive for years to come.

Keywords

Undergraduate medical education, curriculum, competency-based education, teaching methods, research and development

Notes on Contributors

SHELBY S. WEBSTER, MA BMBCh MRCP PGC Medical Education is a Fellow in Medical Education and Physician, Department of Medical Education, Chelsea and Westminster Hospital NHS Foundation Trust, London, UK.

KEVIN P. SHOTLIFF, MBBS MD FRCP DCH is Clinical Tutor and Consultant Physician, Department of Medical Education, Chelsea and Westminster Hospital NHS Foundation Trust, and School of Medicine, Imperial College, London, UK.

LISA BURTON, MBBS is a Fellow in Medical Education and Anaesthetist, Department of Medical Education, Chelsea and Westminster Hospital NHS Foundation Trust, London, UK

References:

1. General Medical Council. Tomorrow's Doctors. [Online]. 2009; [Accessed on 10.02.12]. Available from: http://www.gmc- uk.org/ TomorrowsDoctors_2009.pdf_39260971.pdf
2. Stark P, Ellershaw J, Newble D, Perry M, Robinson L, Smith J, et al. Student-selected components in the undergraduate medical curriculum: a multi institutional consensus on assessable key tasks. *Med Teach*. 2005;27(8):720–725.
3. Woo KT, Wong KS, Lee EJC, Chan CM. How can we Improve Clinical Research in Clinical Practice with Better Research Outcome? *Annals Academic Medicine Singapore*. 2011; 40(11):499-506.
4. Hopper AD, Atkinson RJ, Razak A, Rahim A, Perera A, Jones G, et al. Is medical research within the UK in decline? A study of publication rates from the British Society of Gastroenterology from 1994 to 2002. *Clin Med*. 2009;9(1):22-25.
5. Ryan G, Berrebi C, Beckett M, Taylor S, Quiter E, Cho M, et al. Reengineering the clinical research enterprise to involve more community clinicians. *Implement Sci*. 2011;6:36.
6. Walport M. Medically- and dentally-qualified academic staff: Recommendations for training the researchers and educators of the future. UK Clinical Research Collaboration and Modernising Medical Careers. [Online]. 2005; [Accessed on 10.02.12]. Available from: http://www.nihrtcc.nhs.uk/intetacatrain/copy_ of_Medically_and_Dentally-qualified_Academic_Staff_Report.pdf
7. Harden RM. Ten questions to ask when planning a course or curriculum. *Med Educ*. 1986;20(4):356-365.

8. Murdoch-Eaton D, Drewery S, Elton S, Emmerson C, Marshall M, Smith JA, et al. What do medical students understand by research and research skills? Identifying research opportunities within undergraduate projects. *Med Teach*.2010;32(3):52-60.
9. Robinson L, Drewery, S, Ellershaw J, Smith J, Whittle S, Murdoch-Eaton D. Research governance: impeding both research and teaching? A survey of impact on undergraduate research opportunities. *Med Educ*. 2007;41(8):729-36.
10. Integrated Research Application System. Streamlining the Research Application Process. Integrated Research Application System. [Online]. 2009; [Accessed on 11.02.12]. Available from: www.nres.npsa.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=17782Similar
11. Burgoyne L, O'Flynn S, Boylan GB. Undergraduate medical research: the student perspective. *Med Educ Online*. 2010; 15:5212.
12. Murdoch-Eaton D, Ellershaw J, Garden A, Newble D, Perry M, Robinson L, et al. Student-selected components in the undergraduate medical curriculum: a multi-institutional consensus on purpose. *Med Teach*. 2004;26(1):33-38.
13. Dunn WR, Hamilton DD, Harden RM. Techniques of identifying competencies needed by doctors. Med Teach. 1985; 7:15-25.
14. Low-Beer N, Lupton ML, Higham J. A novel method of defining the core objectives of a specialty undergraduate curriculum. *Med Educ*. 2010; 44:1120.
15. Harden RM, Stamper N. What Is a Spiral Curriculum? *Med Teach*. 1999; 21(2):141-43.
16. Harden RM, Sowden S, Dunn WR. Some educational strategies in curriculum development. The SPICES model. *Med Educ*. 1984; 18:284-297.
17. Knowles MS. Andragogy in action: applying modern principles of adult learning. San Francisco: Jossey-Bass; 1984.
18. Whittle S, Murdoch-Eaton DG. Lifelong learning skills: how experienced are students when they enter medical school? *Med Teach*. 2004;26(6):576-578.
19. O'Neil PA, Morris J, Baxter CM. Evaluation of an integrated curriculum using problem-based learning in a clinical environment: the Manchester experience. *Med Educ*. 2000; 34:222–230.
20. Simpson JG, Furnace J, Crosby J, Cumming AD, Evans PA, Friedman Ben David M, et al. The Scottish doctor—learning outcomes for the medical undergraduate in Scotland: a foundation for competent and reflective practitioners. *Med Teach*. 2002; 24:136–143.
21. Detsky ME, Detsky AS. Encouraging medical students to do research and write papers. *CMAJ*. 2007; 176(12):1719-21.
22. BMA Board of Medical Education. Exploring mentoring. British Medical Association. [Online]. 2004; [Accessed on 11.04.11]. Available from: http://www.bma.org.uk/images/mentoring_tcm41-20377.pdf
23. Oxley J, Fleming B, Golding L, Pask H, Steven A. Mentoring for Doctors: enhancing the benefit. The Doctors' Forum. [Online]. 2003; [Accessed on 16.04.12]. Available from: http://www.academicmedicine.ac.uk/uploads/Mentor1.pdf
24. Bland CJ, Ruffin MT, Characteristics of a productive research environment: Literature Review. *Acad Med*. 1992;67(6):385-397.
25. GMC. Our role in medical education and training. General Medical Council. [Online]. 2012; [Accessed on 10.02.12]. Available from: http://www.gmc-uk.org/education/our_role_in_medical_education.asp
26. Tudiver F, Rose D, Banks B, Pfortmiller D. Reliability and Validity Testing of an Evidence-Based Medicine OSCE Station. [Online]. 2008; [Accessed on 10.02.12]. Available from: http://ebm.oscarmcmaster.org/evaluation/Tudiver%20EBM%20OSCE%20Manuscript%20final%205%2021%2008%20(2).pdf
27. Ilic D. Assessing competency in Evidence Based Practice: strengths and limitations of current tools in practice. BMC Med Educ. 2009;9:53.
28. Dannefer EF, Henson LC, Bierer SB, Grady WT, Meldrum S, Nofziger AC. Peer assessment of professional competence. *Med Educ*. 2005;39(7):713-722.
29. Stefani LAJ. Peer, Self and Tutor Assessment: relative reliabilities. *Studies in Higher Education*. 1994; 19(1):69-75.
30. Taras M. To Feedback or Not to Feedback in Student Self-assessment. *Assessment and Evaluation in Higher Education*. 2003; 28(5):549-565.
31. Tierney WG. Facts and constructs: Defining Reality in Higher Education Organisations. *Rev Higher Educ*. 1987; 11(1):61-73.
32. Kaufman A, Mennin S, Waterman R, Duban S, Hansbarger C, Silverblatt H, et al. The New Mexico Experiment: educational innovation and institutional change. *Acad Med*. 1989; 64(6):285-94.