The basic role of basic science

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As the celebrations of the hundredth anniversary of the Flexner Report become a distant memory, it may be a good time to review the legacy of Flexner one last time. Unfortunately a few page editorial will not do justice to the topic; many others have made more extensive comments on the impact of the report (Duffy 2011; Markel 2010) and *Medical Education* devoted an entire issue to discussion of the impact of Flexner and the evolution of medical education since his time.

At the risk of gross oversimplification, the essence of Flexner's report was to strongly encourage the linkage between the medical school and the university—to establish the fundamental role of basic medical sciences in the medical curriculum. His “gold standard” was the curriculum at Johns Hopkins, which itself emulated the German medical schools of a few decades earlier (Duffy 2011). The immediate impact of the report was the closing of about 1/3 of American and Canadian medical schools that did not meet the standards used in the report, as well as the provision of large sums of Carnegie and Rockefeller money to enhance the remaining schools (Barr 2011).

Arguably, the real impact of the Flexner report occurred half a century later, when, following World War 2, the National Institutes of Health established a grant program (National Institutes of Health 2012) that dramatically increased funding for basic science research in medical schools (from \$8 million in 1947 to \$1 billion in 1966!). Many positions were created for basic scientists, and the Hopkins curriculum, with 2 years of basic science followed by 2 years of clinical became the norm.

Basic science dominated the medical school, whose *raison d'être* was the production of medical scientific knowledge (Duffy 2011). Few academics (but sadly far more lay persons, including some notables like Prince Charles) would challenge the critical role of basic biological science as a catalyst for the stunning advances we have observed in quality and quantity of life in the past century as a consequence of medical progress. But while the marriage of basic science and clinical medicine directed at advances in knowledge is a happy one, it is less clear why the undergraduate medical curriculum should be dominated by biological science. Indeed, while the articles in the special issue of *Medical Education*

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range from support to criticism of the Flexner Report, virtually all acknowledge that we now need a broader consideration of the foundational sciences that includes social sciences and humanities in addition to biological sciences. This theme is repeated in the 100th anniversary Carnegie Report (Cooke et al. 2011).

Challenges to the foundational role of basic sciences in medical education are common and frequent. Indeed, basic scientists are frequently placed in a position of defending their role in medical schools (Drake et al. 2009). Their defense is not helped by the evidence from observation of practicing physicians which shows that they rarely use basic science in diagnosis (de Bruin et al. 2005; Patel et al. 1988).

But the fact that practicing physicians do not appear to consciously use basic science in reasoning very often may not be the whole story. In the first place, with expertise comes familiarity, so that it is rarely necessary for experts to consciously go back to basic principles. As Herb Simon once said, “A problem once solved is not a problem.” Recent studies of clinical reasoning show that expert diagnosis is characterized by a “dual process” model, where initial hypothesis formation may well arise from some form of pattern-recognition process, which is automatic, unconscious, rapid and based on link to prior experiences (System 1) followed by a more systematic confirmation (System 2) (Norman et al. 2007). One experiment (Norman et al. 1994) has shown that expert nephrologists, when faced with a complex problem, do revert to basic science explanations, but presumably these circumstances are rare and more often, the basic science knowledge remains “encapsulated (de Bruin et al. 2005)”.

But even if expert physicians rarely use basic science overtly, this does not necessarily preclude a developmental role for basic science as an organizing conceptual framework in learning clinical medicine. This hypothesis was initially explored by Nikki Woods in a series of experiments for her Ph.D (Woods et al. 2005, 2006, 2007). The basic study approach involved two groups of students who learned about a limited number of (real or fictitious) diseases. One groups simply learned the list; the other were shown the list with a companion basic science explanation. When shown new cases after a delay, performance of the first group fell off by 10–15 %, but the second students showed no decay in performance. The basic science explanation was apparently acting as a mnemonic device to aid memory and facilitate application.

Three papers in this issue elaborate on the developmental role of basic science. Goldszmidt et al. (2011) extended Woods’ findings, using a physics principle (physics of lung sounds) and real clinical cases (COPD, effusion, pneumonia). They showed that learning the physics provided an advantage in clinical diagnosis both immediately after and 1 week after learning.

Neilson et al. (2011) looked at the relation between physiology knowledge and interpretation of echocardiography images with residents and cardiologists. The results nicely illustrate the idea of a developmental role; for residents the correlation between physiology and test interpretation was 0.78, for cardiologists is was 0.03.

Finally, Kulasegaram et al. (2011) examined transfer—using basic science knowledge to explain clinical cases. They showed that providing a common-sense analogy that aids understanding of the concept increased accuracy of explanations by about 50 % both immediately after learning and after a week’s delay.

These studies provide an empirical basis for the concerns expressed by Weatherall (2011) in his “minority opinion” in the special issue of Medical Education, when he states:

[This] is an appropriate time to ... discuss whether well-intentioned efforts to humanize medical students’ medical school experiences and to make students more

responsive to the needs of patients threatens a core value that is as relevant as it was in Flexner's day: namely competence in contemporary biomedical science. (p. 44)

However there is also an important pedagogical point to be made from these studies. First, self-evidently, all the studies examined, not whether the basic science was learned or retained, but whether it was applied to the solution of clinical problems. In this respect, they are similar to the studies of Woods et al. (2005, 2006, 2007) and Baghdady (2009), showing a benefit of basic science in performance on a clinical task, but very different from the many studies of decay of basic science knowledge over time.

Second, the two instructional interventions went beyond simply teaching the concepts to developing specific instructional strategies to ensure that students *really* understood them, and to explicitly show how these concepts were related to clinical problems. This is a fundamental departure from most instruction, both "conventional" and problem-based. In conventional schools, basic science teaching has not really advanced much pedagogically from approaches to public school education of the 19th century, when Latin, logic and grammar were taught as "foundational habits of mind", in the illusion that, since all Romance languages derive from Latin, facility in Latin would automatically make mastery of French, Italian, or Spanish easy. Thorndike disproved this assertion in 1923 (Thorndike 1923), but students still take Latin courses. It is not surprising that, with this kind of instruction, students have difficulty integrating basic science and clinical science (Patel et al. 1991). Problem based learning has its own problems: by making the problem the central element in curriculum, it tends to ignore the critical role of meaning in learning, as concepts are learned in almost random sequence (Neville and Norman 2010). Under these circumstances, students may display serious deficiencies in understanding (Patel et al. 1991).

The critical contribution of these studies is not simply to show that basic science has an important developmental role in students' learning in health sciences, although that in itself is a very useful contribution. But more important, the studies contribute to a recognition that effective instruction in basic science requires specific pedagogical and assessment strategies that go far beyond the traditional "read and regurgitate" approaches that are all too common in preclinical curricula.

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