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The clarion call for a third wave in medical education to optimise healthcare in the twenty-first century

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ABSTRACT

During the years preceding 1910, the education and training of physicians (doctors) -to-be was based mainly on a master–-apprentice model; the primary focus then was on the teaching and development of clinical skills. In 1910, however, Abraham Flexner submitted a highly influential report to the American medical authorities: in it, he recommended that all medical schools should be university-based and that, importantly, medical practice should have a scientific basis strongly underpinned by the basic medical sciences. The recommendation provided the impetus for the design of medical education that begins with a pre-clinical phase to provide the strong scientific foundation for the clinical phase that follows. During the clinical phase, student learning will focus primarily on the clinical sciences relating to the diagnosis, treatment and management of patient care. Thus, two key 'pillars' (the basic sciences and the clinical sciences) of medical education were established; this two pillar model of medical education persisted for many decades thereafter and remained so till today. However, in order to optimise delivery of health care this must be viewed as an 'eco-system' taking into account the practice setting both present and future. The authors will attempt to provide a background to the changing trends in medical education and the changing practice environment, due primarily to the disruptive forces of change in this article.

The central mission of medical education

> The central mission of medical education is to improve the quality of health care delivered by doctors: what doctors do, and how and when they do it depends on the quality of medical education. We must get it right.
>
> (Bligh and Parsell 2000, p. 417)

In their editorial entitled "Taking Stock", Bligh and Parsell (2000) wisely highlighted that the performance of doctors (physicians) in practice is dependent on the "quality of medical education" they received; in this context then, medical education must ensure that the "quality" of education delivered to medical students must be "right" in order to ensure that the new generation of doctors (the end-products of education) will be able to discharge their professional obligations in accordance with expectations. Thus, not only did the editorial by Bligh and Parsell (2000) draw attention to the inter-dependence between doctor performance in practice and the quality of medical education received, but it also underscored the inter-dependence between medical education and practice needs.

In the education and training of today's medical students to become tomorrow's doctors (practitioners) there is, therefore, a clear need to ensure that medical education must always design educational strategies that will contribute to the healthcare needs, demands and challenges of patients and the community in the period under consideration. Thus, reforms in medical education must always ensure that medical graduates (the new generation of medical practitioners) will be fit to deliver twenty-first century healthcare.

This article will attempt to trace how changing trends in medical education have often been the result of changing practice needs due, primarily, to the disruptive forces of change.

The master–apprentice relationship model of medical education

In the years preceding the submission of the Flexner Report (1910), the education and training of medical students to become future doctors (practitioners) was often based on a master–apprenticeship model in which practitioners served as the master, whereas students were the apprentices. The primary focus of teaching was then on the development and acquisition of clinical skills as outcomes of student learning during this period. Thus, the end-products of medical education were mainly equipped with clinical skills for their future practice (Dornan 2005; Rassie 2017).

Establishing the two pillar model of medical education

In 1910, Flexner submitted a highly significant and influential report on the state of medical education in North America to the relevant medical authorities then. Flexner's report of 1910 strongly recommended that all medical schools should be university-based and that medical students must learn the basic science disciplines such as anatomy, biochemistry and physiology before proceeding to learn the clinical sciences; this was aimed at ensuring that the practice of medicine is strongly underpinned by science, thus providing the scientific basis of medicine. Such a model of medical education was readily accepted and

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adopted, not only in North America, but also globally including much of Asia.

The introduction of the basic sciences into the undergraduate medical curriculum firmly established the two key pillars (the basic sciences and the clinical sciences) in medical education. The two pillar model of medical education provided the main impetus for the design of medical education in two phases, beginning with the pre-clinical phase in which student learning is focused on the acquisition of course content knowledge derived from the basic science disciplines and aimed at providing the strong scientific foundation for the clinical phase that follows. During the clinical phase, student learning will focus primarily on the clinical sciences relating to the diagnosis, treatment and management of patients.

The two pillar model of medical education seemed to have lulled many medical educators into complacency, perhaps because "… the reforms equipped health professionals with the knowledge that contributed to the doubling of life span during the 20th century." (Frenk et al. 2010, p. 5).

The disruptive forces of change

> Professional education has not kept pace with these challenges largely because of fragmented, outdated and static curricula that produce ill-equipped graduates.
>
> (Frenk et al. 2010, p. 5).

At the turn of the century, however, alarm bells started to ring: disruptive forces of change progressively made their impact on medical practice and include: advances made in medical knowledge, science and technology; fast changing demographics with increasing number of elderly individuals often with chronic ailments; the changing profile of patients who are often better educated and who often obtain much of their health information from the internet and, are, therefore, often referred to as "expert" patients; diseases of preferred lifestyles such as over-eating causing obesity with complications within the cardiovascular system, and cigarette smoking causing lung cancer as well as complications within the CVS; life-threatening emerging and reemerging infections such as MERS and Ebola, and tuberculosis, respectively (Weatherall et al. 2006; Lunenfeld and Stratton 2013).

The need to reform medical education in response to the disruptive forces of change

> To have a positive effect on the functioning of health systems and ultimately on health outcomes of patients and populations educational institutions have to be designed to generate an optimum instructional process.
>
> (Frenk et al. 2010, p. 11).

The disruptive forces have made it imperative for, both, practice and education to undertake major reforms, as the two entities are inter-dependent systems in the field of healthcare. Thus, several reforms have been strongly advocated in medical education; the reforms relate to the curriculum, as well as instructional and assessment strategies all closely aligned and designed for the educational preparation of today's medical students to become tomorrow's medical practitioners who are fit to deliver twenty-first century patient care which can match the healthcare needs, demands and challenges of patients and the community.

However, it should be noted that all the reforms mentioned above have been undertaken and implemented within the two pillar model system of medical education.

A third wave in medical education: 1. Health systems science

> Even if the basic and clinical sciences are expertly learned and executed, without health systems science, physicians cannot realize their full potential on patients' health or on the population.
>
> (Skochelak et al. 2017, p. viii)

> … it is our efforts around medical education, our exciting accelerating change in medical education initiative that may ultimately be the most far-reaching and impactful.
>
> (Skochelak et al. 2017, p. vii)

The American Medical Association (AMA) expressed serious concern that the "… focus and overall structure [of the 'Medical school curricula'] remain stubbornly captives of early twentieth-century thinking. The result is an ever-widening gap between how physicians in the United States are trained and educated and the realities of the modern health care environment" (Skochelak et al. 2017, p. vii).

In 2013 the AMA launched a program "… to transform and modernize medical education [in the USA by] providing funding for a diverse network of medical schools to innovate, share practices, and push the boundaries of traditional medical education" (Skochelak et al. 2017, p. vii).

The AMA initiative was aimed at "… a strategic realignment … [of its] mission to promote the art and science of medicine and the betterment of public health." In this context then, the Accelerating Change in Medical Education Consortium of the AMA considered the likely requirements of the medical school of the future which resulted in "The emergence of health systems science [as] a key component … .bridging the study of basic and clinical sciences [and, thus, providing future] physicians a broad view of the societal influences and administrative challenges that sometimes complicate patient care" (Skochelak et al. 2017, p. vii).

> For many years … medical education– based largely on an educational model more than a century old – has needed to change in order to address significant gaps in physician training and prepare new doctors to practice effectively in our 21st century health systems.
>
> (AMA 2017)

Thus was born the textbook "Health Systems Science" published by the AMA Accelerating Change in Medical Education Consortium and intended to serve as the text for the study of the third pillar (wave) in medical education that is expected to add value to the study of the two pillars (the basic and clinical sciences) in medical education established more than a century ago. According to Gonzalo et al. (2017) "Health Systems Science is defined as the principles, methods and practice of improving quality, outcomes, and costs of health care delivery for patients and populations within systems of medical care (p. 2)."

Skochelak has also drawn attention in the AMA (2017) document that "No one entity, organization, school,

university or academic institution has all the solutions for reforming medical education. Together we can address today's challenges and make a positive, meaningful difference in how future physicians are trained."

A third pillar (wave) in medical education: 2. Technology-enhanced education

> Technology is changing our world and the practice of medicine unmatched at a pace [unprecedented] in human history.
>
> (Skochelak et al. 2017, p. vii)

> Advanced information-technology is important not only for more efficient education of health professionals; its existence also demands a change in expected competencies.
>
> (Frenk et al. 2010, p. 27)

We now live in the digital age of the internet era which has a strong impact on the practice of medicine. The latter is evolving ever so rapidly with the increasing use of technology and Artificial Intelligence (AI) in the delivery of healthcare. Many of the professional functions of doctors (and other healthcare professionals) are being enhanced through the use of technologies such as robotics, machine learning and data analytics. To envisage the future, it is probably best to reimagine what the future will be like, as already suggested by the former editor of the British Medical Journal in his article entitled "Extrapolation of current trends is a poor way to think about the future, particularly at times of great change" (Smith 1997).

Projects such as the IBM Watson are already using AI to analyze unstructured data to provide information to physicians in order to optimize care for their patients. Technology will continue to enhance the capabilities of physicians (and other healthcare practitioners) to provide effective care to their patients, real-time information to the relatives of patients, and improve the health of communities (Hodson 2018).

The patient care model is also changing from acute and ambulatory care to home care. Patients will increasingly prefer to be cared for in a supportive home environment and this will be made possible with advances in communication technology such as integrating AI-powered Robotics; home monitoring with personal devices triangulating patient information for medical professionals or care teams working remotely.

With such disruptive innovations in the practice of medicine we need to rethink and reimagine how our students (and trainees) should be educated and trained to become effective future healthcare practitioners? There is no doubt that advances in technology, such as AI, will play a major role in the future delivery of healthcare. Physicians will be required by both the patients and employers to improve care outcomes by leveraging on AI-enhanced data analysis. Furthermore, provision of care can be expected to be through the use of remote devices powered by technology at multiple sites by multi-professional teams which may include non-human care providers such as robots (Hooi et al. 2017).

> As with other technologies, the drivers of constructive change are not the hardware or software by themselves, but rather the institutional transformation that the technologies enable ….
>
> (Frenk et al. 2010, p. 27)

Disruptive innovations in the practice of medicine, brought about by simple and more complex technology, have made it imperative for, both, medical practice and, therefore, medical education to implement reforms in appropriate fields of technology. Medical education must, therefore, adapt to and incorporate such newer areas in technology. However, it should be by careful design rather than an odd sprinkling of a module or two during the learning journey of a student (Wartman and Combs 2017).

We envisage that advances in technology will serve to strengthen the third pillar and will be further value-add to medical education in the new millennium (Hooi et al. 2017). Of course the design and delivery of the medical curricula can also be made much easier through the appropriate use of artificial intelligence, especially with the increasing number of students in many institutions today. Personalizing the learning as well as developing learning analytics to enhance and predict how students will perform will also assist students in difficulties and will, therefore, improve the effectiveness of curricular delivery. Furthermore, enhanced personalized device capabilities and technological advances will enable students to access any information anytime worldwide. Personalized Chatbot can assist the learners to make meaning of multitudes of information available. Some of these technologies, such as Chatbot have already been made a part of student learning in some institutions (Mish 2016).

Importantly, we also need to ensure that teachers are first trained and be equipped with the new skills related to technology. There should also be more emphasis on teachers' ability to leverage on learning analytics which should also form a key component of the third pillar in medical education.

Learning analytics

Learning analytics (LA) offers teachers, students and administrators insights into the educational and training process in medical education, from participation, through engagement, toward intermediate and final outcomes of education and training. The LA process can be applied in both traditional, blended, and eLearning (technology enhanced learning or TEL environments), with TEL offering the possibility of real time (near real time) data visualization and analysis (Goh 2017).

The use, and integration of digital content, tools, platforms and processes into traditional teaching and training in medical education offers us the potential to go beyond the "scholarship of discovery, application, integration and teaching" (Glassick 2000) to include "digital scholarship" (Scanlon 2017). This allows us to not only document, make accessible and visible the education and training process through a learning analytics process; but to also combine and use the digital material, as well as metrics of participation, engagement, as well as intermediate and final outcomes of our digital teaching and training process as the basis for educational scholarship, for peer review, critique and for others to build on and modify (Goh 2017).

As we increasingly rely on TEL, which not only expands the scale and reach of our educational and training efforts, we gain both data and visibility of the online and mobile

learning space, which is amenable to data visualization and analysis, both human and artificial intelligence (AI) mediated. Our mobile and online learning platforms, online connected sensors, and AI driven software and robotic teaching and training, and well as health care service delivery tools offer the possibility of reproducibly delivering high quality service, layered with the "human touch", with both AI interfaces and human careers. Just as we blend technology, and face to face learning and training paradigms, we can blend efficiency and service effectiveness of AI and robotics, with the intangibles of human empathy, caring, customization and personalization. Our approach to thriving in an AI and technology mediated landscape is to become "more human", emphasizing the richness of the human and interpersonal experience (Illing 2018), in both healthcare and transformation of education, for example by going beyond Bloom's taxonomy, to augment this for an AI mediated world (Durfee 2018), similar to how we augment healthcare increasingly with AI.

Conclusions

> Educational institutions must now be re-engineered to adapt to this transformation, otherwise they risk becoming obsolete.
> (Frenk et al. 2010, p. 27)

Health Systems Science and relevant technology-enhanced learning should now be included as the third pillar (wave) in the medical curricula of the twenty-first century. This will ensure that the educational preparation and training of future medical practitioners will enable them fit to deliver patient care that can match the healthcare needs, demands and challenges of patients and the community in this new millennium. Inclusion of technology-enhanced learning should not pose a problem; after all, the students of today are considered by many as "digital natives"!

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The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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