Medical Education

Teaching of the basic sciences in medicine: Changing trends

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ABSTRACT
A number of medical schools throughout the world have tried to downsize the basic sciences, but studies have shown that teaching of basic sciences is of importance for the clinical years that lie ahead. While some students endorse this finding, others want instruction in these sciences to be limited in terms of content and time. With the increasing cost of medical education and healthcare, medical schools the world over are trying to contain expenditure on the teaching of the basic sciences. In India, too, instruction in these sciences has been curtailed. This trend may need to be reviewed and the new challenges in this area must be addressed.


INTRODUCTION
Medical students throughout the world are taught basic sciences for 2–3 years in their initial years of undergraduation. Most educators feel that a detailed study of the basic sciences is necessary, though clinical educators may differ on the way they are taught. This idea was initially highlighted by the Flexner report, published in 1910, which emphasized the central role of an ‘academic clinician’ who can apply the principles of basic science to effective clinical reasoning. This model is based on the hypothesis that medical decision-making based on an understanding of the basic medical sciences results in better clinical care.

However, rapid developments in the clinical sciences, which have led to better care of patients, are threatening the concept of instruction in the traditional basic sciences and leading to downsizing, and even downgrading, of the basic sciences. In the early 1900s, the Flexner report led to major reforms in medical education in the USA. A number of medical schools closed and their number came down from 457 to 85 in the next decade. After the Flexner report, a number of departments of basic sciences were established, but these were compartmentalized. Since then, several authors have opined that there is excessive teaching of the basic sciences, and that it is irrelevant and not useful. According to them, the facts/concepts are dealt with in too detailed a manner and students need to memorize these. The facts/concepts are dealt with in too detailed a manner and students need to memorize these. The Flexner 2 report, which came out a century after its predecessor, emphasizes the integration of the basic sciences with the clinical sciences and the teaching of the basic sciences in the context of clinical facts. Budding clinicians do not feel the need for extensive teaching–learning of the basic sciences; they wish to learn only the relevant basic sciences. We need to interpret these changing trends carefully. Do we want to teach only clinical practice during 5–6 years of an undergraduate medical course? Is it good for the future of academics? This debate aside, all studies agree that the basic sciences provide critical knowledge for medical education.

Hence, in the present scenario, the way the basic sciences are being taught is a matter of concern. However, it might not be premature to say that the time is ripe to review the changing trends in the teaching of the basic sciences.

WHAT ARE THE BASIC SCIENCES?
Basic sciences have been labelled as preclinical and paraclinical sciences or sciences which the learning of which does not require students to go to clinics, such as anatomy, physiology and biochemistry. In some cases, they also include pharmacology, pathology and microbiology. However, there are different views on this since pharmacology can have two components: pharmacology and clinical pharmacology. Similarly, pathology and microbiology can have many subdivisions. The time has come to start thinking about the positioning of the basic sciences in the medical curriculum. Some basic science subjects, such as professionalism, ethics, epidemiology, the behavioural sciences and communication skills, are either not taught or are taught in a fragmented manner. These fragments tend to lose their relevance and are not reinforced in the clinical years. Are these subjects basic sciences that are required for an understanding of the clinical sciences? We must take another look at these sciences and define which are the basic sciences that are relevant to clinical teaching and regional needs.

QUALITY AND QUANTITY OF TEACHING OF THE BASIC SCIENCES
After the Flexner report, a number of departments of basic sciences were established, but these were compartmentalized. Since then, several authors have opined that there is excessive teaching of the basic sciences, and that it is irrelevant and not useful. According to them, the facts/concepts are dealt with in too detailed a manner and students need to memorize these. The students, too, are not happy with the many irrelevant lectures. They also feel that this has adversely affected their retention capacity and hindered their preparation for clinical encounters.

Learning is defined as a change in one’s long-term memory. The basic sciences were taught in a passive manner by faculty
members who felt uncomfortable trying to make their teaching relevant to the clinical context. Similarly, clinicians felt uncomfortable teaching basic sciences relevant to the clinical context. This barrier between the faculty that teaches the basic sciences and clinicians is well known.21,22 However, even more contemporary studies agree that the basic sciences remain fundamental to the learning of clinical concepts.5

Concerns have also been raised about the fact that less time was being devoted to the teaching of the basic sciences as a result of the new curricula. In Norway, a new curriculum reduced the time by 70%. The duration of teaching of the basic sciences decreased from 86 weeks in the conventional curriculum to 46 weeks in an integrated curriculum.22 In India, teaching of basic sciences in the first professional year was reduced from 18 months to 12 months in 1995, and this reduced teaching hours.23,24 In the new proposed competency-based curriculum for the undergraduate medical course in India, it has been suggested that the duration of teaching of the paraclinical sciences be reduced from 18 months to 12 months. However, the paraclinical sciences will continue to be taught in the 4th and 5th years as a result of integrated teaching.24 This makes sense as the relevant basic sciences can be taught till the clinical years. The focus should not be on reducing the quantity, but on improving the relevance and quality of teaching. The United States Medical Licensing Examination (USMLE), step 1 has changed the assessment of the basic sciences.8

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CLINICAL REASONING AND BASIC SCIENCES

Some people think that clinical reasoning is independent of the teaching of the basic sciences. However, others think that the latter is a must for logical and well-thought-out clinical reasoning. The teaching of normal (anatomy, physiology, biochemistry) and then abnormal (pathology, microbiology, etc.) conditions helps students to develop logical reasoning, the skills of critical analysis and problem-solving, and the ability to make decisions.25 Earlier studies mention that the teaching of basic sciences might not be relevant when as a clinician, one is trying to find only similarities between two cases. However, when faced with a diagnostic dilemma, one will struggle and realize the importance of the basic sciences. It has been emphasized that if students are not taught the basic sciences in detail, their thinking is very limited when they come across a case or case report in the clinical years. On the other hand, if the basic sciences have been taught in detail, they are in a better position to recall/reconstruct the relationships between clinical features and diagnosis.1,26 Similarly, the ‘encapsulation theory’ suggests that the concepts of basic sciences get encapsulated in clinical facts related to a disease. However, clinicians still say that the time spent on teaching the basic sciences would be better utilized on teaching clinical facts.1 This has led to a debate on the relevance and importance of ‘academic medicine’, in which faculty members pursue teaching and research activities in an institution, versus the importance of ‘clinical medicine’, in which the main emphasis is on the care of the patient.

SURVEYS ON TEACHING BASIC SCIENCES

Surveys of first-year students on the importance of teaching of the basic sciences mostly show the relevance of these for the clinical years lying ahead. The results have been challenged as these students have not been exposed to clinical cases and may not correlate teaching of the basic sciences with clinical reasoning. Final-year students say that only relevant portions of the basic sciences should be dealt with and less time should be devoted to these subjects. Their view is supported by the fact that they are more conversant with clinical cases and hence, can better understand the relationship between the teaching of the basic sciences and future clinical cases. However, there are studies that also suggest that final-year students might have overlooked some of the objectives of teaching of the basic sciences at that time, assuming them to be irrelevant. This could partly be due to a lack of knowledge of the link between the teaching of the basic sciences and clinical reasoning.27

Students taught the basic sciences in the conventional manner gave more importance to the role of these sciences than those following an innovative curriculum. This difference was maintained over the period of clinical studies.28 Also, students following a traditional curriculum in Hong Kong performed better in the basic sciences examinations.29

The age and entry level for medical courses vary from country to country and this, too, could have an impact on the need for teaching of the basic sciences and the manner in which they are taught, e.g. undergraduate-entry (most of Europe, India, China) and graduate-entry (mainly Australia, Canada, the USA) programmes. However, no study has reported that the entry age or prior degrees affect learning in medical schools. While age may lead to greater maturity, it does not translate into better academic outcomes.29

BASIC SCIENCES AND ECONOMICS OF MEDICAL SCHOOLS

The financial slowdown as well as the increasing cost of medical education have burdened medical schools. Departments of the basic sciences are not revenue-earning departments and hence, medical schools have tried to decrease the teaching of these sciences and the associated faculty. This has happened in India as well as globally.30 Fewer options are being offered to these teachers, the avenues of promotion have decreased, the number of teachers required in schools is being cut down by regulatory bodies and the teachers are not offered permanent or regular jobs.15 All this has further discouraged teaching in the basic sciences. Unfortunately, the managements of medical schools are not considering the contribution of the basic sciences to the development of the final product of the school, i.e. a clinician, and the quality that instruction in these sciences adds. The medical schools experimented by pushing teachers of the basic sciences in the direction of research. Unfortunately, the financial slowdown as well as the increasing cost of medical education have burdened medical schools. Departments of the basic sciences are not revenue-earning departments and hence, medical schools have tried to decrease the teaching of these sciences and the associated faculty. This has happened in India as well as globally.30 Fewer options are being offered to these teachers, the avenues of promotion have decreased, the number of teachers required in schools is being cut down by regulatory bodies and the teachers are not offered permanent or regular jobs.15 All this has further discouraged teaching in the basic sciences. Unfortunately, the managements of medical schools are not considering the contribution of the basic sciences to the development of the final product of the school, i.e. a clinician, and the quality that instruction in these sciences adds. The medical schools experimented by pushing teachers of the basic sciences in the direction of research. Unfortunately, the financial slowdown as well as the increasing cost of medical education have burdened medical schools. Departments of the basic sciences are not revenue-earning departments and hence, medical schools have tried to decrease the teaching of these sciences and the associated faculty. This has happened in India as well as globally.30 Fewer options are being offered to these teachers, the avenues of promotion have decreased, the number of teachers required in schools is being cut down by regulatory bodies and the teachers are not offered permanent or regular jobs.15 All this has further discouraged teaching in the basic sciences. Unfortunately, the managements of medical schools are not considering the contribution of the basic sciences to the development of the final product of the school, i.e. a clinician, and the quality that instruction in these sciences adds. The medical schools experimented by pushing teachers of the basic sciences in the direction of research. Unfortunately, the financial slowdown as well as the increasing cost of medical education have burdened medical schools. Departments of the basic sciences are not revenue-earning departments and hence, medical schools have tried to decrease the teaching of these sciences and the associated faculty. This has happened in India as well as globally.30 Fewer options are being offered to these teachers, the avenues of promotion have decreased, the number of teachers required in schools is being cut down by regulatory bodies and the teachers are not offered permanent or regular jobs.15 All this has further discouraged teaching in the basic sciences. Unfortunately, the managements of medical schools are not considering the contribution of the basic sciences to the development of the final product of the school, i.e. a clinician, and the quality that instruction in these sciences adds. The medical schools experimented by pushing teachers of the basic sciences in the direction of research. Unfortunately, the financial slowdown as well as the increasing cost of medical education have burdened medical schools. Departments of the basic sciences are not revenue-earning departments and hence, medical schools have tried to decrease the teaching of these sciences and the associated faculty. This has happened in India as well as globally.30 Fewer options are being offered to these teachers, the avenues of promotion have decreased, the number of teachers required in schools is being cut down by regulatory bodies and the teachers are not offered permanent or regular jobs.15 All this has further discouraged teaching in the basic sciences. Unfortunately, the managements of medical schools are not considering the contribution of the basic sciences to the development of the final product of the school, i.e. a clinician, and the quality that instruction in these sciences adds. The medical schools experimented by pushing teachers of the basic sciences in the direction of research.
BASIC SCIENCES AND RESEARCH
The academic environment in medical schools in the USA changed after the Flexner report. Research became more important than clinics and teaching. The ‘publish or perish’ culture appeared. Teachers of the basic sciences were also investigators. The basic sciences were involved directly in so many discoveries. However, as research became more molecular, teachers of the basic sciences found it increasingly difficult to continue research. The advanced technology, costly equipment and frequent updating of technology were the other problems faced by the basic sciences. Similarly, in India, the publication of research articles is now mandatory for promotions of faculty members. Hence, teachers need to devote a certain amount of time to research. Although this is a good initiative to promote research, it coincides with the decrease in the requirement of faculty to teach the basic sciences. It means that now, fewer teachers are devoting themselves fully to the teaching of these sciences and must also spare some time for research. This arrangement does not seem to benefit the teaching side of the basic sciences.

ATTEMPTED CHANGES IN TEACHING
When most studies mentioned that the role of teaching the basic sciences had diminished, the main reason cited was inadequate equipment/infrastructure. However, this problem has been taken care of, and the challenge is to make instruction in the basic sciences more relevant to the clinical sciences without compromising the importance and content of the former. Even the two approaches to learning—deep learning and superficial learning—confirm this. The key characteristic of the approach of deep learning is the perceived relevance of the subject matter, while lack of relevance is associated with superficial learning. Since the time for instruction in the basic sciences has been reduced, we need to innovate to see to it that they are taught.

Think of learning about Krebs’s cycle in isolation and then applying it in the clinics after 2–3 years. It would be much better to learn about Krebs’s cycle in the clinical context. The objection to this view is that the content may be variable, based on the future needs of physicians. Some of the content may not have an immediate relevance but may be useful in the adoption of new agents and procedures. Hence, a knowledge of the basic sciences differentiates a physician from a technician. It has been seen that students’ retention of knowledge is better when it comes to the paraclinical subjects taught in the clinical years, e.g. pathology and pharmacology, than subjects taught in the preclinical years, e.g. anatomy and physiology. This again highlights the fact that students learn the basic sciences better when there is simultaneous clinical exposure. However, the simple linear manner of learning as suggested by Flexner might not be relevant today as students are more technology savvy. Hence, an innovative approach such as a spiral, which goes upwards, and imparts instruction in topics in small increments to foster reflection, thought and the use of prior knowledge for the development of new knowledge and skills, can be relevant in teaching of the basic sciences in the clinical context. A more integrated curriculum that emphasizes the clinical facts may be more appropriate.

In the UK, gradual progress has been made towards such integration. In India, various attempts have been made to introduce integrated teaching over the years. At present, a competency-based integrated curriculum has been proposed. This curriculum curtails the duration of the second professional year from 18 to 12 months and the subjects taught will be integrated in the final professional year too. It also includes a foundation course of 2 months’ duration, and stresses horizontal and vertical integration, the integration of ethics, attitudes and professionalism into all phases of learning, early clinical exposure and self-directed learning. The integration can be achieved in various ratios, on the basis of the year of the course (Fig. 1). However, we need to be careful when trying to understand and implement integration. True integration is not merely a matter of various departments taking lectures/practicals on a similar topic in parallel. Integration is the ‘organization of teaching matter to interrelate or unify subjects frequently taught in separate academic courses or departments’. It occurs when the students and teachers connect and relate relevant components of the curriculum in meaningful ways. Thus, the implementation of an integrated curriculum may be challenging. In India, a few other efforts have been made in this direction, e.g. early clinical stimulus and integrated teaching.

Integrated curricula have been associated with encouraging results worldwide. The first fully integrated curriculum was tried at McGill University, when the basic sciences were integrated in the fourth year curriculum. In 19% of medical schools in the USA and 24% in Canada, courses or experience in the basic sciences are a requirement for the clinical years. The fully integrated, spiral curriculum, involving repeated interdisciplinary blocks and longitudinal threads, has been used by Norman and Wilkerson et al. The integration of the basic sciences on a curriculum-wide e-learning platform has been attempted in the Netherlands. There has been a shift from discipline-based to competency-based learning.

In Australia, teaching of the basic sciences runs in parallel with the other themes in a 4-year programme. The Australian Medical Council does comment favourably if clinicians are involved in instruction in the basic sciences and these sciences are integrated in the later clinical years. In the USA, full integration of the basic sciences throughout all four academic years is being tested. Introducing these sciences in the fourth year was found to be very satisfactory in helping students to understand concepts. Medical education reforms were introduced in Germany in 2003, but medical schools are still struggling to teach the basic sciences in the clinical context. In Japan, reforms have been suggested and will be implemented soon. However, the process has been very slow.

CONCLUSION
The basic sciences still occupy a large part of the preclinical curriculum, but are under constant threat. Clinicians should be
involved in teaching these sciences. Students are of the view that the application of the basic sciences to clinical practice should be reinforced early on in the medical course. The teachers should be more oriented to general principles than factual knowledge. Medical councils as well as students worldwide have already highlighted this. Teaching anatomy, physiology, etc. in isolation will not have long-term effects or help in the retention of knowledge. The knowledge will remain inert and soon evaporate. The mere learning of concepts does not guarantee that a student will be able to use these to solve problems. Hence, we must pay more attention to the application of the concepts learnt to enable students to solve problems. We must try to place the teaching of the basic sciences in a clinical context and then reinforce these sciences in the clinical years. We must also include the behavioural sciences, communication, ethics, professionalism, statistics, etc. in the curriculum. Re-examining the learning strategies and tactics involved in the teaching of the basic sciences in the current scientific, social and economic circumstances is a major challenge to medical education.

REFERENCES