

Integration in Medical Education: A Brief Introduction for Physiology Educators

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Abstract

This brief review summarized topics fundamental to curriculum integration especially for physiology educators who are not familiar with integration across the boundary of disciplines. Readers will learn about definitions, key terms with meaning, classification of integration commonly used in medical education. Additionally, learning theories behind integration and simple steps on how to implement integration in class sessions, courses, and a program level will be introduced. For readers who prefer in-depth details and theories regarding integration, related references are also provided.

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Introduction

The needs for medical education reform

T *True success is not in the learning, but in its application to the benefit of mankind*’ is one of the principles from Prince Mahidol Adulyadej of Songkla, the father of modern Thai medicine and public health. In order to effectively provide healthcare for the society, the medical community has to understand the ever-changing needs of the society. As medical knowledge and societal expectation for the best healthcare are growing and getting more complicated, medical educators face diverse challenges to provide appropriate learning experience for medical students to be ready for healthcare services in the 21st century. Therefore, medical education has to be adaptable to the ever-changing demands from the society. The World Federation of Medical Education (WFME), for example, was initiated to be ‘a global forum for medical educators worldwide’ to guarantee that the appropriate medical education has been implemented.¹

Before Abraham Flexner published his influential report entitled ‘Medical Education in the United States and Canada’ in 1910,² most of the medical schools in the US were not affiliated with the university system. Furthermore, there was no standard procedure to recruit, to teach, or even to evaluate medical students. Most of the learning activities were in lecture format and the opportunity to learn from patients was limited. However, after Flexner’s report,

the needs for medical schools to better prepare doctors with scientific knowledge, clinical skills, and professionalism in response to societal expectation were increased. Medical schools started to affiliate with universities and hospitals. One of the pioneers of this ‘*medical school-research university-hospital*’ model is the Johns Hopkins Medical School where science was introduced into the medical curriculum and the discipline-based medical education was implemented.³ This revolution in medical education around the time of Flexner’s report was critical to the advancement of healthcare during the 20th century.

Concerning about constant changes in demand for health care services, Flexner advised that medical education should be reevaluated within the next 25-30 years after his publication in 1910. However, the discipline-based medical education that mainly focuses on scientific knowledge has largely been dominated for more than a hundred years.

From the late 20th century, information has been exploded including medical knowledge and also the invention of the internet has revolutionized the way people learn. To be more specific, most of the medical information is not currently limited to healthcare professionals. Anyone, including patients, can reach for the information related to his or her health. As the society demands better healthcare services, medical schools have been challenged to evolve.

Curriculum integration during the transformation of medical education

In order to provide healthcare for the ever-changing society, various international workforces, such as *A global independent commission on Education of health professionals for the 21st century*⁴ and the *Carnegie foundation*, published various articles focusing on the needs and recommendations for medical education reform.⁵⁻⁷ Among various reforms are to shift medical education from discipline-based to

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system-based curriculum and to implement an outcome-based or a competency-based curriculum.

From the article 'Health professionals for a new century: Transforming education to strengthen health system in an interdependent world,' the authors recommended to implement the competency-based curriculum with the promotion of interprofessional and transprofessional education.⁵ Additionally, the report from the Carnegie foundation entitled 'Educating physicians: A call for reform of medical school and residency' also recommended to establish strong connections between formal and experiential knowledge across the continuum of medical education.⁶ To achieve these purposes, integration is one of the effective strategies to improve the quality of medical education for the 21st century. For example, one of the WFME global standards for quality improvement of basic medical education emphasizes that the medical school should ensure the integration in its curriculum.⁸

Integration in medical education

Definitions

One of the challenges for implementing integration into a curriculum is a lack of precise definition.⁹ In general, integration in education can simply be defined as 'any intentional uniting or meshing of discrete elements or features.' For the context of medical education, integration has also been loosely defined. Harden, one of the prominent pioneers in medical education, suggested in 1984 that 'Integration is the organization of teaching matter to interrelate or unify subjects frequently taught in separate departments.'¹⁰

Subsequently, various definitions for integration in medical education have been coined based largely on the definition proposed by Harden. For example, integration has been viewed as an introduction of clinical experiences into the earlier years of medical curriculum, or a combining of separate courses or clinical experiences into a single unit. Integration was also applied to discrete topics such as ethics for the first year medical students and principles of palliative care along the whole course of the medical curriculum.⁹

Interestingly, even in medical schools that successfully implemented integration in the curriculum, the discrepancies regarding perceived definitions of integration remained among faculty members, students, and administrative staffs. In the long run, the precise definition of integration, at least in a particular medical school, may be necessary for the success of curriculum reform. Therefore, in 2015, Association for Medical Education in Europe (AMEE) published AMEE guide number 96 suggesting an updated definition that 'Integration is a fully synchronous, trans-disciplinary delivery of information between the foundational sciences and the applied sciences throughout all years of a medical

curriculum.'⁹

Classification

Integration, based on the time period when subjects have been weaved together, can be categorized into horizontal, vertical, and ultimately, spiral integration.⁹

*Horizontal (concurrent)*⁸ integration refers to an integration of various subjects in a finite time period. To illustrate, an integrated urinary system course for the preclinical medical students is a result of weaving related topics that once separately taught in various subjects such as Physiology, Biochemistry and Anatomy. For example, a topic of chemical buffers was initially a part of a medical biochemistry course, whereas topics of respiratory and renal involvements in acid-base balance were provided in two different sections of a medical physiology course. After horizontal integration was successfully implemented, those three topics were delivered together in an acid-base balance topic. Apparently, horizontal integration reduces content redundancy. More class time can be allocated for additional learning activities promoting higher levels of learning or for self-directed learning.

*Vertical (sequential)*⁸ integration refers to an integration of various subjects across time periods, especially across the boundary between preclinical and clinical years. In other words, the vertical integration enables an introduction of clinical experiences to medical students earlier in the curriculum and promotes integration of basic or foundational sciences throughout the clinical years. In an integrated urinary system course for the preclinical medical students, for example, a nephrologist demonstrated the relevance of the concepts from an acid-base balance class and introduced the clinical approaches to common acid-base disturbances through clinical case scenarios.

Considering the boundary between preclinical and clinical years, applying principles of vertical integration will transform 'H-shaped' into 'Z-shaped' curriculum.⁹ (Figure 1) Successful vertical integration will motivate and engage preclinical students to course materials. On the other hand, it will provide opportunities for students in clinical years to revisit the foundations underlying clinical knowledge.

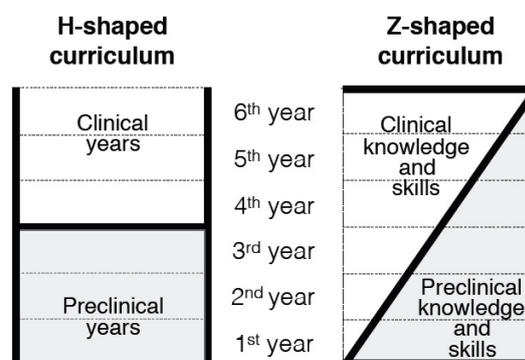


Figure 1 A 6-year medical curriculum in H-shaped and Z-shaped format.

Spiral integration results from the successful implementation of both horizontal and vertical integration. This level of integration enables an evolution of concepts regarding foundational sciences, clinical sciences, clinical skills, health promotion, and ethics all along the curriculum including the planned opportunities for students to revisit the previous knowledge and to advance the current knowledge to the higher levels of learning. A distinguished example of the spiral curriculum can be observed at the University of Dundee in Scotland, United Kingdom.

Theories behind integration

Adult learning theories and cognitive psychology support the benefits of integration in medical education. Adult learning theories refer to various theories explaining how an adult learns. The three major adult learning theories are andragogy, self-directed learning, and transformational learning.¹¹ Andragogy, or the art and science of helping adults learn,¹¹ suggests that adults learn better when the purposes of a lesson are known and they prefer to solve real-world problems relevant to what they learned. For cognitive psychology, it is a scientific study of how the higher-order functions of the brain work including how human learns.

Based on both adult learning theories and cognitive psychology, integration will facilitate learners to apply knowledge with real world situations and will prolong retention of knowledge to a greater extent. As independent adult learners, medical students learn more effectively when they are able to

connect course materials to the real world situations or problems. When presented with integrated contexts, information will be easier to organize and to transfer for the future retrieval. Medical educators can motivate students easily by integrating contents with related contexts such as clinical problems, current news, or even instructor's own stories. Ultimately, integrated courses will increase internal motivation in medical students.

How to implement integration

In 1991, Fogarty published '*Ten ways to integrate curriculum.*' In the introduction, he wrote, '*To help the young mind discover roots running underground whereby contrary and remote things cohere and flower out from one stem is the mission of both teachers and learners. Educators can achieve this mission, in part, by integrating the curriculum.*' The article also introduced ten models of curricular integration ranging from the fragmented model to the networked model.¹² Fogarty's work has influenced curriculum integration of various fields including medical education.

In 2000, Harden introduced the integration ladder as a tool to emphasize the continuum of integration in medical education from 'isolation' to 'trans-disciplinary.'¹³ The eleven points along the integration ladder was briefly summarized in Table 1.

Due to limited publication on how to apply integration in a medical curriculum and the lack of precise definition for integration, some medical schools experienced difficulties when introducing integration to their community. Interestingly, after

Table 1 The 11-step integration ladder (after Harden, 2000¹³). Brief description of each step from isolation, or no integration, to trans-disciplinary is given.

Steps	Brief descriptions
Isolation	Each subject in a curriculum is separately designed. Instructors did not know the contents covered in related sessions. A curriculum is fragmented.
Awareness	Within a subject, instructors know and be aware of the contents covered in related sessions, but do not explicitly demonstrate integration.
Harmonization	Instructors teaching the same subject communicate and adjust their teaching. Opportunities for instructors to connect are deliberately planned.
Nesting	In some sessions, instructors demonstrate connection with others existing disciplines. However, No integration outside these particular sessions exists.
Temporal co-ordination	Related sessions from separate disciplines are intentionally organized in a specific time period. Therefore, a parallel teaching is initiated.
Sharing	Two or more separate disciplines identify overlap of contents and design learning activities together. A joint teaching session is initiated.
Correlation	In a discipline-based curriculum, a whole or a major part of some courses is integrated from two or more separate disciplines.
Complementary	Both discipline-based and integrated approach are present in a curriculum. A majority of learning activities is integrated.
Multi-disciplinary	System-based curriculum is implemented. Focuses are shifted from contents of a specific subjects or disciplines to competencies of students.
Inter-disciplinary	Higher degree of integration is presented in a curriculum. Specific subjects or disciplines are less mentioned.
Trans-disciplinary	A curriculum focuses on how to solve real life problems. Instructors provide activities and environments that facilitate internal integration within learners.

integration was incorporated, there have been discrepancies regarding integration among faculty members, medical students, and administrative staffs. These gaps, in a long run, may hinder or limit the effectiveness of the integrated curriculum.¹⁴

The AMEE guide number 96 focusing on integrated curriculum⁹ proposed that *no* universal instruction manual exists for implementing integration. Each medical school has unique strengths and limitations. However, the authors proposed three suggestions when planning for integration. *First*, provide unified definitions for your institution. Therefore, every stakeholder speaks the same language. *Second*, integration is not just coordination. Integration requires preparation. The related course contents should be weaved together, rather than just putting one content after another. *Third*, the foundational sciences should be preserved in varying degrees along the curriculum.

Based on the author's experience, the critical success factor for an integrated course is the faculty member. All members, and administrative staff, have to understand the concepts and languages of integration through an effective faculty development program. Next, faculty members who used to teach overlapping courses have to discuss and design learning activities together. At first, most faculty members found these processes overwhelming. Along the way, nevertheless, some faculty members realized the benefits of integration not only for medical students, but also for their own learning and growth as a medical teacher.

To successfully implement integration across the boundary of disciplines throughout the curriculum, the framework for integration is recommended to apply at all levels of curricular design from program level, course level, to session level.¹⁵

The program level is where the mission of an institution, the goals of the program, and the measurable outcomes of the program are initiated. To implement integration, the program committees should carefully consider reasons for integration and scopes of integration or to what extent that subjects will be integrated. Importantly, the program should communicate and prepare faculty members, administrative staff, and students for the reform. Although it is impossible to convince everyone to change, less resistance to change can still be achievable through the well-prepared implementation.

At the course level, the decision should be made regarding the degree of integration. Available tools, such as the integration ladder¹³ (Table 1), are helpful to choose a level of integration that is appropriate for the course. Importantly, more attention should be paid for course preparation. Frequent and effective communication between faculty members from related disciplines is critical for the success of any integrated course. A course schedule that facilitates integration should be decided at this level.

For *the session level*, learning activities should be

carefully organized. Briefly, based on active learning principle, contents should be presented with relevant contexts.¹⁶ Previously learned knowledge required for the session should be activated and corrected. Learners will process new information better when basic knowledge is activated. If any pre-session reading or assignments are required, the direction should be announced in advance with appropriate out-of-class time to complete the assignment.

Conclusion

Integration has successfully been implemented in many medical programs with convincing evidence of improved learning outcomes in medical students.¹⁷ Foundational sciences including physiology are essential for any medical curriculum. As physiology educators, knowledge regarding integration is beneficial for an inevitable curriculum change during the current medical education reform. Implementation of integration in a curriculum is a demanding task that requires effective leadership at the program level, collaborative effort from faculty members, administrative support from staff, and cooperation from students. A success of curriculum integration relies largely on an institution-wide collaboration.

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Conflict of Interest

None to declare.

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