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Friendship or vicarious relationship? Exploring the intricacies faced by basic sciences in integrated curricula

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Abstract

In response to the evolving needs and reports on medical education, many medical schools have been pursuing curricular integration. Contrary to Abraham Flexner who persuaded that teaching of medical sciences, from basic to clinical, should be a critical component of the discipline based curriculum, 'integration', in its purest sense unifies separate areas of knowledge which quenches the needs of adult learners. However, most medical schools struggle with integrating their curricula owing to the confusion derived from diverse definitions and multiple learning theories. A common criticism of integrated curriculum is that students will not see the relevance of basic sciences and this significantly minimizes the role of basic sciences in medical education. The crux of integration is achieving the balance of clinical and basic sciences in a manner that best serves the student to maximize student engagement and knowledge retention. In this paper, we made an attempt to address the contextual issues existing in medical schools, the changing role of basic sciences in present day medical education and the optimal strategy to achieve effective integration of basic sciences. We propose that a dynamic interconnectedness happening at various levels is more important to achieve effective integration rather than mere deliberate unification of individual disciplines.

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Introduction

The progressive decrease in duration available for teaching basic sciences and increase in the volume of competencies required to be mastered by a student mandates an evolution in the contemporary medical education. Many voices advocate re-organisation of the curriculum based on realistic case scenarios or problems, which makes the learner more involved, rather than learning things that may be useful at some time in the future. The relatively recent emphasis on competency-based medical education which integrates emphasis on the process of learning with clearly defined and measurable learning outcomes[1] may help in unifying different disciplines making medical education a wholesome process.

Integrated curriculum can be defined in the words of Shoemaker[2] as "education that is organized in such a way that it cuts across subject matter lines, bringing together various aspects of the curriculum into meaningful association to focus upon broad areas of study". This challenges the discipline based curriculum which compartmentalizes medical education as pre-clinical, para-clinical and clinical sciences. The planned learning experiences in integrated curriculum would help students to look at issues from multiple perspectives and acquire a systemic approach which would hone their diagnostic reasoning skills in future. This also would be a feasible way to avoid fragmented, redundant and isolated facts taught in individual disciplines.[3]

The traditional methodologies opted for teaching basic sciences lacked inquiry based approach which made students memorize unrelated facts rather than learning to think like a clinician.[4] The compartmentalization also makes it difficult for the students to recall the relevant basic science knowledge when required in future years.[5] The concept of teaching for understanding (TfU), which forms the base of integrated curriculum, makes the learner to apply his or her knowledge appropriately and creatively in a range of varied circumstances, including practical

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settings and situations.[6]

How to achieve an effective integration?

Achieving a responsive, integrated curriculum requires the understanding and influence of both linear (additive) and non- linear (multiplicative) learning and practice situations.[7] The learning situations depending upon certainty and agreement can be "webbed" (central theme linked to different subject areas) or "shared" (planning in two disciplines organised around shared concepts or ideas) or "threaded" (taking learning to synthesis level; inter-departmental teams focusing on thinking skills integrating with content).[8] The curriculum integration can also be viewed at multiple levels: the whole (a module or unit, the curriculum), the part (a single event, discipline or subject, a person) and the greater whole (the university, the hospital, the health system and society).[9]

Millennial generation learners want opportunities for authentic experiential learning that emulates the real world, have a desire for flexibility, are comfortable with diversity and want to know why they are learning the material they are being taught.[10,11] The non-linear (multiplicative) outcomes, if provided by the curriculum integration, can infuse creativity and innovation in learners which can be seldom sowed in traditional discipline based or "Flexnerian" learning perspective.[9]

The shift in the curriculum from "fragmented" discipline based state to integrated learning activities based state mandates rigorous reviewing and planning followed by documentation and mapping its micro-components.[5] The number of factors working in a complex environment can be mapped out using an active landscape diagram. For example, integration can be achieved within a department, so that key concepts can be connected leading to review, reconceptualization and assimilation of ideas. In this case, teachers and students are close to agreement and learning outcomes become more predictable. On the other hand, if integration is planned across disciplines, chances of system getting far from agreement are there. This might cause little to no coordination among students and teachers, which ultimately lowers the productivity of learning environment.[12] Nevertheless, the first four steps of *Harden's*[13] integration ladder can be effectively achieved at subject or discipline level. Especially, the "nesting/infusion" step in which contents from different subjects are drawn to enrich the existing curriculum helps in achieving better outcomes. Taking a comprehensive image of various components of the existing curriculum might be of immense help in planning the organization and layout of the integrated curriculum.

Changing role of basic sciences in present day medical education

The importance of basic sciences in laying down the foundation for sound clinical knowledge cannot be doubted. However, there is little evidence[14] that clinicians use their basic sciences knowledge in routine clinical diagnosis. In other words, the way basic sciences are taught to the students in the first two years of their medical education is not prudent enough to stimulate clinical reasoning. Patel et al[15] had mentioned that, "…the basic sciences and the more practical clinical knowledge form two separate domains with their own individual structures and the clinical information cannot be embedded into the basic science knowledge structure". This can be explained by the fact that the corpus of facts taught in the basic sciences are not effectively embedded in a causal model which might provide a meaningful context of learning leading to enhanced memory of the material.[16] In discipline based curriculum, there are only common assumptions about curricular progression, priorities given to individual topics and appropriate teaching methodologies used for implementing it. This seldom allows to revisit basic sciences later, demanding integration to take place within the learners.

Out of the four goals established by the *Carnegie report*[17] for medical education, two important goals namely the needs of integrating knowledge and clinical experience at all levels and developing habits of inquiry, calls for restructuring the curriculum to meet the existing needs. Studies suggest that increasing the focus on learning in context, revisiting basic sciences in a longitudinal way and incorporating clinical medicine throughout the course gives students a better reason to learn.[18,19] Also, it is a widely acknowledged fact that even with the guidance of core anatomy syllabus, educators still find it difficult to judge the level of anatomical details that should be taught to medical students.[20,21] It also mandates the pivotal role of clinicians' perspectives to support anatomy teaching, ensuring that anatomy is not taught to a high level of detail that is simply not required in the majority of clinical settings.[22]

A recent study[22] highlighted that most participants perceived the need for revisiting cadaveric material at the beginning of each clinical placement and this would be helpful in integrating anatomy vertically as well. Over the past 20-30 years, anatomy curricula have been reduced owing to the reduction in the time available and this might have an effect on future training of surgeons. It should also be taken into account that there was a perceived lack of anatomical knowledge[23,24] among Australian medical graduates after introduction of integrated problem based curricula. In essence, the transition from discipline based curriculum to an integrated format by itself poses lots of conceptual challenges which has to be addressed based upon the specific needs and academic idiosyncrasies of the institution.[25]

"Integrated curriculum", in a wider sense, remains as a buzzword. Nevertheless, the underpinnings of the integrated curriculum are not taken into account in a true sense in many instances. For example, "early clinical exposure" postings as mandated by the Medical Council of India is being carried out in many institutions with the intention that a simple juxtaposition of clinical postings might aid in promoting cognitive interaction within a student. Leaving behind the curricular interrelationships i.e. adopting a reductionist approach to integrate the disciplines presumably have a negative effect.[26,27] This seldom solves the purpose of an ideal integration should involve application of knowledge gained from the basic sciences in the clinical environment and vice-versa.[28]

Do we justify the role of basic sciences in integrated curricula?

Bandiera et al[29] had suggested the replacement of "basic sciences" and "clinical sciences" with "foundational science" and "applied science", respectively. Vogel[30] had described that each discipline turns out a spigot of information on students which forces the students to question the relevance of discipline as such. In a study[31] involving senior undergraduate students, many felt that that their memory of basic science medical courses is less than expected and the content of basic sciences taught to them was not relevant to their later clinical work or studies. Bruner[32] states that, "A curriculum as it develops should revisit these basic ideas repeatedly, building upon them until the student has grasped the full formal apparatus that goes with them".

It can be made out that, an effective integration of basic sciences requires "distillation" of the existing curriculum to get rid of the unnecessary detailing and defining a 'core knowledge' which should then be assimilated in various phases of medical education.[33] El-Bab et al found that most students do not recall clinical facts using their basic sciences knowledge background.[34] They opined that two types of knowledge (clinical sciences and basic sciences) are independently acquired and recalled. This reinforces the fact that the 'core knowledge' should be reinforced by integrating vertically into the medical training. In addition to this, students who venture into medical careers demanding a more detailed knowledge (for example, surgery postgraduates requiring specialist anatomy training) shall be supplemented with a specialised training of foundational science at later stages, according to their requirement.

Irrespective of the curricular reforms, the common rationale behind teaching basic sciences i.e. making the medical students understand the mechanism of disease as a whole rather than mere recognition and treating should form the *modus operandi* for generating hypothesis. A study,[35] compared the diagnostic accuracy of the nephrologists, second year and first year residents and found that nephrologists, as they better knew regarding the mechanism of diseases ordered relatively few, targeted additional tests to arrive at the diagnosis. The traditional discipline based curriculum demands "transfer" of concepts learned in one context to solve analogous problem in another context.[36] For example, it is indeed hard to expect "transfer" of concepts from the first year anatomy classroom, where abdominal viscera are taught one over another into an operation theatre 2 or 3 years later, where the concepts must be applied in a patient undergoing duodenal perforation closure. Blizard et al[37] quoted the attitude of students towards the basic sciences as: "...passing the examinations, forgetting the whole business, and then getting on with the job of becoming a doctor." In addition, if students feel that whatever they learn in the first year will soon be lost, they tend to focus on superficial learning, with a sole intention to pass the examinations which in turn reduces their interest in basic sciences.[38] These voices echoed in the report from the Howard Hughes Medical Institute (HHMI) [39] which proclaimed that, "in recent years the scientific knowledge important to learning and practice of medicine has changed dramatically, while the approach to science education in the premedical curricula has essentially remained unchanged". It is the apt time to consider remodelling the basic sciences (or more appropriately foundational sciences) to support development of encapsulating concepts which structures their knowledge in a scientific way. In words of Jones and Keith,[40] "all medical schools should adopt promising pedagogical innovations to enrich the learning experience for students [including] underscoring the relevance of 'basic science' topics by integrating pre-clinical and clinical education throughout the curriculum".

Challenges and constraints of integrating basic sciences

One hundred years of Flexnerian legacy has resulted in a discipline-specific curriculum design which seldom encouraged cross-talk between and across the medical disciplines. This leads to development of own vested interests in the basic sciences discipline as such. It is not so easy for few disciplines to lend themselves in building an integrated curriculum. For example, regional anatomy does not fit appropriately into an organ system based approach. To say, curricular integration disrupts the topographical contiguity of body regions.[41] In the traditional discipline based approach, the cadaveric anatomy based on dissection is sequentially organized in itself. This approach aims at imprinting the visualization of structures, tracing its course and observing the spatial relationships. Adopting an organ system based approach disrupts the entirety of the dissection courses and this costs the imprinting of structures as such. Head and neck anatomy loses its integrity when it gets dismantled as respiratory, endocrine and neuroscience modules. Traditionalists use this as a convenient argument point warning that, it might terribly affect the surgical acumen of the medical students in future. Also, they point out that dissection, which was once considered as a 'rite of passage' might lose its lustre and students might fail to master the dissecting skills (if considered as a competency). Drastic reduction in the time allotted to gross anatomy would also force the students to get satisfied with prosected specimens. This might lead to increased rates of surgical errors owing to the damage of related structures. An alarming 7- fold increase in claims associated with anatomical errors submitted to the Medical Defence Union between 1995 and 2000[42] is a tell-tale sign of inadequate spatial anatomical knowledge. As Harden's ladder of integration[13] is climbed up the traditional course gets disintegrated and there could be disruption of the logical progression of knowledge. Bridging different concepts which were once in tandem in traditional curriculum might tax the students as it becomes akin to solving puzzle pieces of different sorts. Van der Veken et al[43] who reported a steeper learning curve for students in an integrated curriculum as compared to a traditional curriculum.

Yet another factor which potentially impedes the knowledge transfer is having the concept tightly bound to the problem/case. The problem or case is usually presented to motivate learning and this could divert the students too much from basic sciences, particularly during the early stages of medical education.[44] Lastly, the assessment pattern should be revamped to include measurement of reasoning capacity based on application of basic sciences in clinical contexts which promulgates a deeper and holistic approach to learning. The ideal way of integration is 'cognitive integration' which is supported by day-to-day microanalysis of pedagogical strategies and aids effective integration of foundational and applied sciences in the learner, not simply in the paper.[45]

Conclusion

Basic sciences are undergoing a phase of metamorphosis by which they are made more scientifically inquisitive and appropriate for present day clinical practice. It is necessary to make changes in the curriculum to achieve cognitive integration at all levels extending from the first year of medical education till residency. The active teaching – learning methodologies should aim at providing an encapsulated knowledge in a way which the physicians access, analyse and use the information to achieve diagnosis. In other words, an effective integration of foundational sciences and applied sciences should aim at honing the diagnostic reasoning ability of the students to achieve diagnostic accuracy. A righteous balance between not inflating the curriculum with sophisticated details and at the same time, not allowing inexorable declination of standards required for further clinical practice, must be established. The insights provided in this article are based on the perceptions of the role of basic sciences in this era. Further researches, should aim at marshalling evidences to justify the modifications required in basic sciences and their role in integrated curricula.

Ethical approval

Not applicable.

Competing interests

The authors declare that there is no conflict of interest.

Authors' contributions

DK has defined the core concept, made the literature search, and written the primary manuscript. AB has done the critical reviewing of the manuscript, finalised the final submission draft along with manuscript editing.

References

1. Morcke AM, Dornan T, Eika B. Outcome (competency) based education: an exploration of its origins, theoretical basis, and empirical evidence. Adv Health Sci Educ Theory Pract. 2013;18(4):851-63. doi: 10.1007/s10459-012-9405-9.
2. Shoemaker BJE. Integrative Education: A Curriculum for the Twenty-First Century. OSSC Bulletin. 1989;33(2):n2.
3. Lipson MY, Valencia SW, Wixson KK, Peters CW. Integration and thematic teaching: Integration to improve teaching and learning. Language Arts. 1993;70(4):252-63.
4. Wilkerson L, Stevens CM, Krasne S. No content without context: integrating basic, clinical, and social sciences in a pre-clerkship curriculum. Med Teach. 2009;31(9):812-21. doi: 10.1080/01421590903049806.
5. Atwa HS, Gouda EM. Curriculum integration in medical education: a theoretical reviewIntellectual Property Rights: Open Access. 2014;2(2):113. doi: 10.4172/ipr.1000113.
6. Quintero GA, Vergel J, Arredondo M, Ariza MC, Gómez P, Pinzon-Barrios AM. Integrated medical curriculum: advantages and disadvantages. J Med Educ Curric Dev. 2016;3. doi: 10.4137/jmecd.s18920.
7. West BJ. Homeostasis and Gauss statistics: barriers to understanding natural variability. J Eval Clin Pract. 2010;16(3):403-8. doi: 10.1111/j.1365-2753.2010.01459.x.
8. Fogarty RJ, Pete BM. How to Integrate the Curricula. 3rd ed. Thousand Oaks, California: Corwin; 2009.
9. Mennin S. Integration of the sciences basic to medicine and the whole of the curriculum. In: Bin Abdulrahman KA, Mennin S, Harden R, Kennedy C, eds. Routledge International Handbook of Medical Education. London: Routledge; 2015. p. 171-87.
10. Johnson SA, Romanello ML. Generational diversity: teaching and learning approaches. Nurse Educ. 2005;30(5):212-6. doi: 10.1097/00006223-200509000-00009.
11. Levett C. Talking about the generations. Aust Nurs J. 2010;18(2):56.
12. Hafferty FW. Beyond curriculum reform: confronting medicine's hidden curriculum. Acad Med. 1998;73(4):403-7. doi: 10.1097/00001888-199804000-00013.
13. Harden RM. The integration ladder: a tool for curriculum planning and evaluation. Med Educ. 2000;34(7):551-7. doi: 10.1046/j.1365-2923.2000.00697.x.
14. Patel VL, Evans DA, Groen GJ. Biomedical knowledge and clinical reasoning. In: Evans DA, Patel VL, eds. Cognitive Science in Medicine. Cambridge: MIT Press; 1988. p. 53-112.
15. Patel VL, Groen GJ, Scott HM. Biomedical knowledge in explanations of clinical problems by medical students. Med Educ. 1988;22(5):398-406. doi: 10.1111/j.1365-2923.1988.tb00774.x.

16. Woods NN, Neville AJ, Levinson AJ, Howey EH, Oczkowski WJ, Norman GR. The value of basic science in clinical diagnosis. Acad Med. 2006;81(10 Suppl):S124-7. doi: 10.1097/00001888-200610001-00031.
17. Cooke M, Irby DM, O'Brien BC. Educating Physicians: A Call for Reform of Medical School and Residency. San Francisco: Jossey-Bass; 2010.
18. Wilkerson L, Stevens CM, Krasne S. No content without context: integrating basic, clinical, and social sciences in a pre-clerkship curriculum. Med Teach. 2009;31(9):812-21. doi: 10.1080/01421590903049806.
19. Rizzolo LJ, Rando WC, O'Brien MK, Haims AH, Abrahams JJ, Stewart WB. Design, implementation, and evaluation of an innovative anatomy course. Anat Sci Educ. 2010;3(3):109-20. doi: 10.1002/ase.152.
20. Collins JP. Modern approaches to teaching and learning anatomy. BMJ. 2008;337:a1310. doi: 10.1136/bmj.a1310.
21. Hegazy AMS, Minhas L. Reflection of the type of medical curriculum on its anatomy content: trial to improve the anatomy learning outcomes. Int J Clin Dev Anat. 2015;1(3):52-63. doi: 10.11648/j.ijcda.20150103.11.
22. Leveritt S, McKnight G, Edwards K, Pratten M, Merrick D. What anatomy is clinically useful and when should we be teaching it? Anat Sci Educ. 2016;9(5):468-75. doi: 10.1002/ase.1596.
23. Smith JA. Can anatomy teaching make a come back? ANZ J Surg. 2005;75(3):93. doi: 10.1111/j.1445-2197.2005.03381.x.
24. McHanwell S, Davies DC, Morris J, Parkin I, Whiten S, Atkinson M, et al. A core syllabus in anatomy for medical students-Adding common sense to need to know. Eur J Anat. 2007;11(S1):3-18.
25. Simunovic VJ, Hren D, Ivanis A, Dørup J, Krivokuca Z, Ristic S, et al. Survey of attitudes towards curriculum reforms among medical teachers in different socio-economic and cultural environments. Med Teach. 2007;29(8):833-5. doi: 10.1080/01421590701589201.
26. Muller JH, Jain S, Loeser H, Irby DM. Lessons learned about integrating a medical school curriculum: perceptions of students, faculty and curriculum leaders. Med Educ. 2008;42(8):778-85. doi: 10.1111/j.1365-2923.2008.03110.x.
27. Dahle LO, Brynhildsen J, Behrbohm Fallsberg M, Rundquist I, Hammar M. Pros and cons of vertical integration between clinical medicine and basic science within a problem-based undergraduate medical curriculum: examples and experiences from Linkoping, Sweden. Med Teach. 2002;24(3):280-5. doi: 10.1080/01421590220134097.
28. Brauer DG, Ferguson KJ. The integrated curriculum in medical education: AMEE Guide No. 96. Med Teach. 2015;37(4):312-22. doi: 10.3109/0142159x.2014.970998.
29. Bandiera G, Boucher A, Neville A, Kuper A, Hodges B. Integration and timing of basic and clinical sciences education. Med Teach. 2013;35(5):381-7. doi: 10.3109/0142159x.2013.769674.
30. Vogel WH. Relevance of "irrelevant" facts in medical education: the value of basic science teaching for later medical practice. Acad Med. 1993;68(2 Suppl):S27-8. doi: 10.1097/00001888-199302000-00026.
31. D'Eon MF. Knowledge loss of medical students on first year basic science courses at the University of Saskatchewan. BMC Med Educ. 2006;6:5. doi: 10.1186/1472-6920-6-5.
32. Bruner JS. The process of education. Cambridge, MA: Harvard University press; 1960. p. 13.
33. Snelling J, Sahai A, Ellis H. Attitudes of medical and dental students to dissection. Clin Anat. 2003;16(2):165-72. doi: 10.1002/ca.10113.
34. El-Bab MF, Sheikh B, Shalaby S, El-Awady M, Allam A. Evaluation of basic medical sciences knowledge retention among medical students. Ibnosina J Med Biomed Sci. 2011;3:45-52.
35. Norman GR, Trott AD, Brooks LR, Smith EKM. Cognitive differences in clinical reasoning related to postgraduate training. Teach Learn Med. 1994;6(2):114-20. doi: 10.1080/10401339409539657.
36. orman G. The essential role of basic science in medical education: the perspective from psychology. Clin Invest Med. 2000;23(1):47-51.
37. Blizard PJ, Carmody JJ, Holland RA. Medical students' retention of knowledge of physics and chemistry on entry to a course in physiology. Br J Med Educ. 1975;9(4):249-54. doi: 10.1111/j.1365-2923.1975.tb01934.x.
38. Kastrinos W. A study of the retention of biological facts by high school biology students. Sci Educ. 1965;49(5):487-91. doi: 10.1002/sce.3730490513.
39. Howard Hughes Medical Institute. Scientific Foundations for Future Physicians. Washington AAMC; 2009.
40. Jones CA, Keith LG. Medical tourism and reproductive outsourcing: the dawning of a new paradigm for healthcare. Int J Fertil Womens Med. 2006;51(6):251-5.
41. Bolender DL, Ettarh R, Jerrett DP, Laherty RF. Curriculum integration = course disintegration: what does this mean for anatomy? Anat Sci Educ. 2013;6(3):205-8. doi: 10.1002/ase.1320.
42. Ellis H. Medico-legal litigation and its links with surgical anatomy. Surgery. 2002;20(8):i-ii. doi: 10.1383/surg.20.8.0.14518.
43. Van der Veken J, Valcke M, De Maeseneer J, Schuwirth L, Derese A. Impact on knowledge acquisition of the transition from a conventional to an integrated contextual medical curriculum. Med Educ. 2009;43(7):704-13. doi: 10.1111/j.1365-2923.2009.03397.x.
44. Cognition and Technology Group at Vanderbilt. The Jasper Project: lessons in curriculum instruction, assessment and professional development. Mahwah (NJ): Lawrence Erlbaum Associates; 1997.
45. Kulasegaram KM, Martimianakis MA, Mylopoulos M, Whitehead CR, Woods NN. Cognition before curriculum: rethinking the integration of basic science and clinical learning. Acad Med. 2013;88(10):1578-85. doi: 10.1097/ACM.0b013e3182a45def.