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REVIEW

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Integration of clinical anatomical sciences in medical education: Design, development and implementation strategies

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Abstract

For the last 20 years, undergraduate medical education has seen a major curricular reform movement toward integration of basic and clinical sciences. The rationale for integrated medical school curricula focuses on the application of knowledge in a clinical context and the early ability to practice key skills such as critical thinking and clinical problem-solving. The method and extent of discipline integration can vary widely from single sessions to entire programs. A challenge for integrated curricula is the design of appropriate assessments. The goal of this review is to provide a framework for clinical anatomy educators with definitions of integration, examples of existing integration models, strategies, and instructional methods that promote integration of basic and clinical sciences.

KEYWORDS
anatomy education, cognitive integration, curriculum integration, teaching innovation

1 | INTRODUCTION

Over the last few years, institutions have shifted anatomy instruction away from stand-alone courses to parts of integrated courses and/or curricula (McBride & Drake, 2018). However, the strategies for anatomy integration in medical education vary widely among institutions, ranging from session and course level to program level integration. At the course level, anatomy has been integrated with clinical sciences such as pathology (Rae et al., 2017), clinical imaging (Barry et al., 2019), and clinical examination skills (Boon et al., 2002). Anatomy has also been integrated into organ or system-based curricula (Brooks et al., 2015). Furthermore, it has been integrated into specialty-specific senior electives such as emergency medicine, orthopedics, radiology, obstetrics and gynecology to highlight clinical relevance and application (Morgan et al., 2017). The wide range of these different strategies has created a need to define and explain the rationale for integration, to provide examples of effective strategies based on the experiences of different institutions, and to present guidance on how to approach anatomy integration in medical education.

1.1 | The meaning of integration in medical education

There is a lack of consensus on the definition of integrated curricula in the literature. Although the term "integration" has become ubiquitous in medical education, definitions, interpretations and implementation strategies have varied greatly among medical schools. According to Harden et al. (1984), integration is defined as "the organization of teaching matter to interrelate or unify subjects frequently taught in separate academic courses or departments." Irby et al. (2010) described integration as the balanced combination of formal knowledge in the basic, clinical, and social sciences with clinical experience. Brauer and Ferguson (2015) proposed a clarified definition of an integrated curriculum as

> a fully synchronous, trans-disciplinary delivery of information between the foundational sciences and the applied sciences throughout all years of a medical school curriculum (p. 318).

The scope of integration can range from a single session to a course, a phase of a curriculum, or even an entire program. The level of integration can vary from isolated to trans-disciplinary according to Harden's framework of an "integration ladder" (Harden, 2000). Furthermore, models of integration can include horizontal integration across disciplines, vertical integration across time to eliminate the barrier between basic and clinical sciences, and spiral integration where basic and clinical sciences are integrated across time and discipline, that is, a combination of horizontal and vertical integration.

1.2 | The rationale for curriculum integration

Over the last two decades there has been a call for reform in medical schools and a need for more curriculum integration, particularly as it relates to foundational sciences and clinical skills. An assessment of clinical skills education strongly suggested earlier integration of foundational and clinical skills by emphasizing the need for "a continuing opportunity to learn and practice skills throughout the undergraduate medical school years" (Corbett & Whitcomb, 2004). Furthermore, Finnerty et al. (2010) established the Flexner Revisited Study Group and concluded that basic science content relevant to clinical practice should be integrated with clinical applications, and be taught "across the entire [Undergraduate Medical Education] UME experience." The rationale for this integration was to enhance critical thinking, clinical reasoning and problem-solving skills through the application of foundational concepts and principles.

Given the various interpretations of what it means to have an integrated curriculum and a strong rationale for its implementation, the goal of this review is to provide an outline with examples of existing integration models, strategies, and a selection of teaching methods to promote integration, particularly as it relates to clinical anatomy. The review expands on the strategies at the session level that support anatomy educators in implementing integration irrespective of the overall adoption of an integrated curriculum by their institution. In addition, session level integration has been reported to have the most meaningful effect on students' learning (Kulasegaram et al., 2013).

2 | INTEGRATION MODELS

While integration is a term applied to most curricula, its implementation strategies differ between medical school curricula and other fields. Various integration models are established to guide the implementation of integrated curricula. In what follows we have outlined the most common integration models represented in medical and higher education.

2.1 | Integration ladder

The integration ladder, described by Harden (2000), uses an 11-step process to describe integration across a curriculum. The 11 steps of the ladder are: (1) isolation, (2) awareness, (3) harmonization, (4) nesting, (5) temporal coordination, (6) sharing, (7) correlation, (8) complementary, (9) multi-disciplinary, (10) inter-disciplinary, and (11) trans-disciplinary. Step one, or isolation, represents complete lack of integration, when each course teaches in a silo with no regard to content being taught in other concurrent courses. In the final step (11), trans-disciplinary, there are no explicit themes or topics, but rather a "field of knowledge as exemplified in the real world." This phase of integration is best modeled in full immersion clinical rotations. The ladder model allows for a spectrum of integration; however, true trans-disciplinary integration is not always feasible or appropriate in all situations. Most of the integrated medical school programs implement step (5), temporal coordination, where teaching of a discipline is timed to be parallel or concurrent with teaching of other related disciplines. For example, the teaching of anatomical and physiological sciences is coordinated, but the learners are left to make the connection between the two disciplines themselves.

2.2 | Horizontal integration

Horizontal integration of curricula spans across disciplines within a finite time (Brauer & Ferguson, 2015). In this model, all courses relevant to the unit are taught in a systematic manner so as to complement and build on each other. For example, in first-year courses, anatomy, physiology, biochemistry, and neurobiology are combined. This helps to diminish redundancy and provide students with more time for independent study and greater satisfaction with their education (Klement et al., 2011). However, the most common example of horizontal integration is the use of themed blocks in medical integration. These blocks are typically organized by organs, life stages, or major disease themes.

2.3 | Vertical integration

Vertical integration of curricula strives to combine foundational with clinical sciences (Quintero et al., 2016). A curriculum with vertical integration spans across time and disrupts the traditional barrier between the basic and clinical sciences (Brauer & Ferguson, 2015). A Z-shaped model was described by Wijnen-Meijer et al. (2009) in which they proposed that curricula start primarily with all basic sciences and progress through the years to finish with mostly clinical sciences. In ideal scenarios, horizontal and vertical integration of curricula are concurrent. Earlier clinical exposure in this model was seen to increase student confidence in selecting a future specialty, and to improve perceived preparation for postgraduate training (Wijnen-Meijer et al., 2009, 2010). In relation to anatomy education, clinical anatomy using cases can be vertically integrated across the entire 4 years of medical school (Doomernik et al., 2017).

2.4 | Spiral integration

In a spiral integration model, the foundational and clinical sciences interact equally through all phases of a curriculum, with common themes weaved throughout and uniting the two (Harden, 1999). Common themes within spiral integration include: clinical methods, ethics, and health promotion. The spiral model allows for the application of prior knowledge and experience through the concepts of basic, clinical, and social sciences. This model is supported by the General Medical Council, Liaison Committee on Medical education, and Australian Medical Council (AMC), which requires integration throughout the curriculum (Brauer & Ferguson, 2015).

3 | INTEGRATION STRATEGIES

Integration is viewed as a strategy for achieving curricular goals, not as a goal in itself. A starting point for designing and developing an integrated curriculum is to map the current curriculum to Harden's ladder (Harden et al., 1984), then to identify the step it has achieved on the curriculum ladder, and finally to determine what is needed to move the program up the ladder. Curriculum mapping (Harden, 2001) is also a strategy that helps to identify instructional contents, teaching methods, curriculum sequence and assessment techniques. This makes the curriculum more transparent and demonstrates links among its elements. In addition, decisions about integration activities should be aligned at the program, course and session levels to maximize the benefits of integration (Goldman & Schroth, 2012; Kulasegaram et al., 2013).

3.1 | Program-level integration

Program-level integration is guided by the mission of the institution and the overall goals of the program. The latter provides rationales for integration and identifies the educational requirements of the learner (Goldman & Schroth, 2012). To achieve these goals, measurable objectives are established to assess whether the goals are met. At the program level, institutions select from the different types of integration models, that is, vertical, horizontal or spiral. For example, case studies have been deployed in clinical anatomy using both vertical (Doomernik et al., 2017) and spiral (Abu-Hijleh et al., 2005) integration.

3.2 | Course-level integration

At the course level, integration could be achieved by the application of a basic science principle or concept in a clinical situation, or by basic science and clinical science faculty sharing teaching of integrated contents (Kulasegaram et al., 2013). Scott (1994) described the integration of anatomy in a systems course (including cardiovascular, renal, gastrointestinal, endocrine and reproduction) using case histories. In another study, Hansen and Krackov (1994) integrated small group case-based exercises into a traditional human anatomy course, which was welcomed by students who appreciated the valuable opportunity to practice presentation and leadership skills.

An example of sharing teaching between an anatomist and a clinician was reported by Bass et al. (2018). A pancreatic cancer team-based learning (TBL) module was developed to teach abdominal anatomy in a gastrointestinal organ system module, and the TBL activity was co-facilitated by an anatomist and a clinician.

3.3 | Session-level integration

Session level integration has the most meaningful educational effect, where an integrated schema of basic and clinical sciences is built in the learner's memory (Kulasegaram et al., 2013). At the session level, faculty make decisions related to the objectives, content, sequencing, and teaching methods. However, it is important to select learner-centered approaches and to focus on selecting contents that allow for integration of basic and clinical sciences.

For successful integration to occur, learners need to build cognitive associations between basic and clinical science, a process that can require educator assistance (Kulasegaram et al., 2013). This means providing cause-and-effect relationships between basic sciences and clinical findings, and highlighting the essential role of basic sciences in supporting clinical reasoning. This is achieved by allowing basic science information to become a key organizational principle for understanding clinical knowledge, that is, the basic science knowledge forms a cognitive framework for anchoring clinical knowledge (-Kulasegaram et al., 2013, 2015). Knowledge is retained most effectively when the way in which it is organized matches the way in which it is to be used (Ambrose et al., 2010). Thus, teaching medical students about basic science in the context of clinical examples, and explicitly making connections among concepts through integrated presentation of material, should enhance long-term retention and deeper understanding.

Session-level strategies described by Goldman and Schroth (2012) include: (1) Preparation (e.g., reading assignments, questions, problems, self-learning modules [SLM]); (2) Linking (e.g., helping students to expand their initial schema about the topic and letting them use that schema to facilitate the processing of new information; (3) Engagement (e.g., providing relevance, guidance, and opportunities for reflection and discussion); and (4) Transfer (e.g., including strategies for future retrieval when the learned knowledge and skills are applied to other clinical situations).

4 | SELECTION OF TEACHING METHODS TO PROMOTE INTEGRATION

This section discusses selective teaching methods that have been used to deliver integrated anatomical sciences sessions, with some examples of how integration was implemented. However, it is important to understand that integration is not linked to specific delivery or teaching methods, but rather to the content being taught, for example, selecting contents that allow for integration of basic and clinical sciences.

4.1 | Case-based learning

According to AAMC's curriculum inventory, case-based learning (CBL) is defined as the use of patient cases (actual or theoretical) to stimulate discussion, questioning, problem solving, and reasoning on issues pertaining to the basic sciences and clinical disciplines (Anderson, 2010). The hallmark of how CBL helps students to learn is linking of theory (classroom-based) to practice (clinical), with strong emphasis (Clough et al., 2004; Stewart & Gonzalez, 2006) on the integration of basic knowledge and clinical management (Beech & Domer, 2002; Bowe et al., 2009; Chan et al., 2008). CBL involves teaching basic science and clinical concepts in the context of patient scenarios to provide a practical and applied setting for the knowledge. Most CBL is tied to problem-based learning (PBL) and TBL activities, which are discussed below.

Many schools have used CBL methods to integrate anatomical sciences and clinical sciences. Cleveland Clinic Learner College of Medicine has implemented weekly clinical cases to introduce anatomical information that is reinforced using prosected cadavers and imaging (Drake, 2007). Eisenstein et al. (2014) described the Cadaver Biopsy Project at Boston University School of Medicine as a way to link students' cadaver experience with other basic sciences and clinical courses. Biopsies of cadavers obtained during the first-year gross anatomy course were used to develop clinical cases for histology, pathology, and radiology courses. Clough et al. (2004) at Southern Illinois University described their curriculum as resource session-enhanced, case-based tutor-group oriented. The sensorimotor systems and behavior (SSB) unit included neuroscience, gross anatomy, cell biology, biochemistry, embryology, pharmacology and genetics. The case-based tutorials in SSB provided substantial clinical training and practical experience in physical and neurological examination, directly integrated with basic science knowledge.

4.2 | Problem-based learning

MedBiquitous (2016), the AAMC's Curriculum Inventory Working Group Standardized Vocabulary Subcommittee, described PBL as the use of carefully selected and designed patient cases that require the learner to acquire critical knowledge, problem-solving proficiency, self-directed learning strategies, and team-participation skills like those needed in professional practice. The small group in PBL focuses on the process of discovery, which should help in developing problem-solving, independent learning, and teamwork skills. In a PBL curriculum, the patient-based cases do not necessarily include sufficient anatomical content. There are similarities between PBL and CBL, but CBL is a guided inquiry, whereas PBL is an open inquiry, which means more guidance is given during CBL.

There have been concerns that anatomy is overshadowed in integrated problem-based curricula (Galey, 1998). To ensure that anatomy is adequately taught in an integrated problem-based curriculum, self-directed anatomy modules (Zehr et al., 1996) and dissection/prosection (Azer & Eizenberg, 2007) were used to augment the PBL curriculum.

Yiou and Goodenough (2006) described 20 years of experience in a problem-based anatomy curriculum using clinical cases at the Harvard Medical School. The anatomy curriculum is covered during the first 8 weeks of medical studies. It is an original combination of discussions of clinical cases in small groups with work in gross anatomy, histology and radiology laboratories. Lectures are reduced to a minimum and emphasize general concepts. In this setting, anatomy learning is mostly led by students who have prepared for the different laboratory sessions and tutorials. The implementation of PBL in the teaching of anatomy requires a close follow-up of each student with regular feedback on their work. Tutorials must be considered as a cornerstone between lectures and work in laboratories. Traditional aspects of anatomy teaching such as work in dissection laboratories are given an important role as they aim to clarify misunderstood points. Yiou and Goodenough (2006) described a Clinical Anatomy course designed to bridge basic anatomy with clinical clerkships. The course is given in the second year, after the traditional anatomy dissection course; students revisit anatomy during small group discussions of clinical cases. The primary method used to bridge basic anatomy with clinical clerkships is problem-based teaching in small groups. Eight or nine students meet twice weekly for 1.5 h to discuss case narratives (paper cases), with the help of a faculty member. Each case is disclosed progressively over two or three meetings.

4.3 | Team based learning

TBL is described by Parmelee et al. (2012) as an active learning and small group instructional strategy that provides students with opportunities to apply conceptual knowledge through a sequence of activities that includes individual work, teamwork and immediate feedback. TBL is a form of collaborative learning that engages learners in activities within a small group that works independently in classes with high learner to faculty ratios (Anderson, 2010). Although it is a small group learning method, there is emphasis on the team process, which can require faculty training and TBL workshops.

The positive effect of implementing TBL on the teaching of anatomical sciences was reported as an increase in NBME subject scores (Vasan et al., 2011), improved performance of students in the lower quartile (Koles et al., 2010), improved attitude toward working in teams (Huitt et al., 2015), and positive student experiences (Martinez & Tuesca, 2014). To achieve better learning outcomes, TBL and other teaching methods were used as a hybrid method to deliver the integrated content (Johnson et al., 2012). A weekly TBL and a modified PBL format were used to introduce and discuss clinical cases, while lectures and laboratories were designed to establish a link between gross anatomy and the clinical application of anatomical knowledge (Johnson et al., 2012). TBL was also an effective method for integrating anatomy and cross-sectional imaging or teaching anatomy in clinical contexts. For example, at the University of Alabama/Birmingham, TBL modules were developed and activities were co-facilitated by an anatomist and a clinician to teach abdominal anatomy in a gastrointestinal organ system module (Bass et al., 2018).

4.4 | Blended learning

The term blended learning has different meanings among medical educators. Most definitions describe blended learning as a simple combination of technology-mediated instruction and face-to-face, instructor-led training (Bonk & Graham, 2012; Garrison & Vaughan, 2008; Rooney, 2003). However, blended learning is also described as a combination of different pedagogical approaches (e.g., constructivism, behaviorism, cognitivism) to produce an optimal learning outcome with or without instructional technology (Driscoll, 2002). In general, blended learning is the integration of technology-based student-centered and teacher-centered learning. It is not limited to one teaching method but integrates different methods rooted in different learning theories (Khalil et al., 2018).

Pickering and Swinnerton (2019) showed that anatomy curricula are becoming increasingly populated with blended learning resources, which exploit the increasing availability of educational technology. The educational literature postulates that the use of technology can support students in achieving higher learning outcomes by increasing engagement. Pereira et al. (2007) replaced more than half of the face-to-face lectures on the anatomy of the locomotor apparatus with online materials and seminars, and demonstrated improved academic performance. Johnson et al. (2012) described the blending of traditional didactic teaching of anatomy with various teaching modalities (models, imaging, computer-assisted learning, PBL, surface anatomy, peer teaching, and TBL). Green and Whitburn (2016) replaced more than half of their face-to-face lectures in a second-year undergraduate anatomy course with online interactive videos, but the number of hours for practical and clinical anatomy classes remained almost the same. Their blended approach resulted in improved learning outcomes but also in a higher perceived workload. The use of anatomy videos to compensate for the reduction in anatomy teaching time improved laboratory scores, and was well received by medical students (Topping, 2014).

Blended learning approaches have also been implemented in teaching radiological anatomy (Colucci et al., 2015; Shaffer & Small, 2004; Webb & Choi, 2014). Radiological anatomy e-learning was integrated into the existing anatomy course in a new blended teaching and learning curriculum (Webb & Choi, 2014). Strategies for integrating technology into embryology teaching have also been described (Nieder & Nagy, 2002). No difference in overall class performance was found when face-to-face embryology lectures were replaced with online recorded lectures supplemented by fewer face-to-face classes (Beale et al., 2014). Online SLMs were used during a 17-week Human Body Structure and Function module, which coordinated and integrated instruction in anatomy, physiology, neuroscience, microanatomy, embryology, and basic radiology (Khalil et al., 2010). The module was delivered through a combination of instructional approaches, which primarily included interactive lectures and laboratory classes, with a smaller amount of TBL and small group CBL. The SLMs were developed to provide the knowledge necessary to underpin discussions and clinical applications in subsequent large-group classroom encounters.

4.5 | Simulation

Simulation is defined as the technique of imitating the behavior of some situation or process (economic, military, mechanical, etc.) by creating a suitably analogous situation or apparatus, especially for the purpose of study or personnel training (Bradley, 2006). This definition of simulation includes a broad range of activities that are applicable to clinical simulation. In AAMC's curriculum inventory (MedBiquitous, 2016), simulation is defined as a method used to replace or amplify real patient encounters with scenarios designed to replicate real health care situations using lifelike mannequins, physical models, standardized patients, or computers. Methods of simulation include the use of live standardized patients and technically advanced manikins that can recreate clinical signs and symptoms.

In a review by Okuda et al. (2009), multiple reports were identified showing that the use of simulation increased the effectiveness of teaching basic science and clinical knowledge and procedural skills. Anatomical education in the simulation setting is best represented by the use of standardized patients and part-task trainers, which can be simple anatomical models, interactive patient manikins, or the more complex surgical task trainers (Rosen, 2008). Standardized or simulated patients are usually people hired to play the role of patients and provide students with a controlled educational environment in which to practice patient contact (Cleland et al., 2009). Standardized patients are crucial for providing students with a setting in which to practice their physical exam skills safely (Dinh et al., 2015; Hoppmann et al., 2015), identify and locate anatomical structures by ultrasound (Hoppmann et al., 2015), and apply anatomical knowledge to surface landmarks and the location and palpation of underlying organs (Cleland et al., 2009).

Clinical anatomy is integrated during clinical skills sessions, which are typically housed in facilities for simulation-based medical education (Akaike et al., 2012). It is built on active and adult learning theories and offers learners technical and non-technical skill training (Akaike et al., 2012). It is an effective venue for integrating anatomy, clinical medicine and clinical reasoning (Akaike et al., 2012). In addition to an environment of enhanced experiential learning, simulation provides a natural context for integrating basic and clinical sciences (Gordon et al., 2004). Clinical anatomy has a unique place in surgical simulation education (Champion & Gallagher, 2003). In emergency medicine residencies, medical simulation provides supplemental clinical training without exposing patients to the risks associated with trainee teaching (Binstadt et al., 2007). New technologies are helping to drive an expansion of simulation in medical education, including the use of virtual reality systems to create a virtual patient environment for simulation activities (Caudell et al., 2003).

All the teaching methods discussed above (e.g., CBL, PBL, TBL, blended learning, simulation) integrate anatomical content in a patient scenario. At the session level, a clinical problem is introduced to provide context for the anatomical information, and students are encouraged to participate actively in the learning process.

5 | ASSESSMENT OF INTEGRATED CURRICULUM

Rigorous evaluation of an integrated program requires comprehensive and systematic assessment at different levels using Kirkpatrick's four-level evaluation model (Kirkpatrick & Kirkpatrick, 2006): (1) learner satisfaction or reaction to the program (e.g., student's perception of the quality of their own learning); (2) measures of learning attributed to the program (e.g., knowledge and skills assessment); (3) changes in learner behavior in the context for which they are being trained (e.g., application of the learned knowledge); and (4) the program's final results in its larger context (e.g., overall success of the program). However, most of available studies only report evaluations at levels 1 and 2. Stakeholder perceptions of curriculum integration are reported to differ between students, faculty and administrators (Khalil & Kibble, 2014; Muller et al., 2008). Integration of the basic and clinical sciences was reported to result in a higher level of mastery of clinical knowledge (Van der Veken et al., 2009).

In assessing students' learning outcomes, it is important to refer to curriculum inventory and mapping. A curriculum map facilitates the alignment of students' outcomes with the instructional contents and instructional methods (Harden, 2001). Therefore, a link between contents and methods with those outcomes is established for valid assessments. Curriculum mapping is also a useful tool for identifying gaps and redundancies.

Brauer and Ferguson (2015) reviewed strategies for assessment in integrated curricula, which included reflection exercises, a combination of multiple-choice questions with essay questions, clinical reasoning exercises, creation of concept maps, long essays, written reports, and progress tests. These various assessment tools encourage students "to reflect on the foundational science concepts that led them to clinical decision-making" (Brauer & Ferguson, 2015).

Many studies have reported positive students' perceptions and attitudes toward integration of anatomical and clinical sciences in medical curricula (Abu-Hijleh et al., 2005; Boon et al., 2002; Grignon et al., 2016; Webb & Choi, 2014). For example, the integration of radiological imaging was positively perceived by medical students to enhance the quality of anatomy instruction (Grignon et al., 2016; Webb & Choi, 2014). Students felt more confident in correlating anatomy with surgery during surgical clerkship rotation, and their post-test scores were significantly higher than their pre-test scores (Abu-Hijleh et al., 2005).

Additionally, horizontal and vertical integration of anatomy with clinical sciences improved students' understanding of the anatomical basis for clinical examinations (Boon et al., 2002). Anatomy integration was also reported to improve students' performance on subject examinations significantly (Klement et al., 2011).

6 | CHALLENGES OF IMPLEMENTING INTEGRATION

Integration of anatomical sciences into medical education poses practical issues that should be considered if it is to be made successful. These issues are summarized in the following categories: (1) program design, (2) faculty training, (3) availability of resources, and (4) educational contexts.

The major challenge at the program and course levels is the difficulty of evaluating the intended outcomes of integration owing to the complexity and the contributions of multiple confounding factors to successful learning (Kulasegaram et al., 2013). Other challenges include the organizational structure of traditional departments, the disagreement between basic and clinical sciences faculty on how much basic science should be taught, and the reduced time allocated for basic sciences in medical curricula (Bowe et al., 2009). In addition, many schools use the regional approach to teaching anatomy, but it is a difficult method to integrate with more system-based courses (Bolender et al., 2012).

Faculty development and training are important for promoting curricular change (Steinert et al., 2007). Faculty will not necessarily be prepared to teach in an integrated curriculum that requires student-centered and active learning methods (Goldman & Schroth, 2012). Therefore, faculty must go through a process of new skills development and should acquire the necessary knowledge for making curricular change. For successful integration, on-going training for faculty on active learning pedagogy and educational technology is critical (Khalil & Kibble, 2014).

Redesigning curricula or courses to integrate anatomical sciences requires more effort and additional resources (Goldman & Schroth, 2012). Computer-based resources have been used successfully to integrate anatomical and clinical sciences and to support student-centered learning (Caudell et al., 2003; Pickering & Swinnerton, 2019). Technology integration also facilitates self-directed group learning, and faculty members need the skills to select appropriate online resources or develop additional resources.

Educational contexts in term of facilities, such as classrooms and laboratories, affect the outcomes of integration efforts. The design of these facilities should support student-centered learning and accommodate group activities. Redesigning existing traditional facilities is challenging and costly.

7 | RECOMMENDATIONS AND CONCLUSION

There are multiple models to guide curriculum integration. However, successful integration is achieved when it is aligned at the program, course and session levels. At the session level, faculty have the opportunity to be more innovative in integrating anatomical sciences in support of the overall program goal of integration.

For successful integration of anatomical sciences, the following viewpoints should be considered:

1. Successful integration occurs at the session level when basic science knowledge provides a framework for understanding clinical problems, which results in better diagnostic skills and retention of knowledge.

2. The contents in a patient scenario can be integrated by introducing a clinical problem. Patient scenarios confer clinical relevance on biomedical science contents and improve student motivation.
3. Learner-centered approaches should be used and the students engaged in the learning process. Active participation of students in the learning process improves performance.
4. Active participation of students in small group settings should be promoted.
5. A better understanding of cognitive processes and theories provides guidance for improved learning.

We recognize that not all medical schools support integration at the program or the module/course levels. However, the faculty teaching anatomical sciences sessions could be more innovative in integrating anatomical and clinical sciences at the session level. To achieve successful learning outcomes, it is important to select anatomical science content that integrates easily with clinical science content, that is, basic science concepts that are applicable to clinical scenarios. The goal is to help learners build cognitive associations between basic and clinical sciences, and to teach cause-and-effect relationships between basic and clinical concepts.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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