REVIEW ARTICLE

The Benefits and Challenges of Clinical Work-based Surface Anatomy Learning Among Preclinical Medical Students

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ABSTRACT

Knowledge on surface anatomy enables medical students and graduates to locate anatomical structures exteriorly, improve their clinical and procedural skills and interpret ultrasonographic and radiographic images. Hence, a standard surface anatomy knowledge is essential for attainment of clinical skill competency. Nevertheless, there is lack of attention given on surface anatomy in the medical curriculum as it is usually delivered didactically or during self-study by the students. Owing to limitations in cadaveric dissection in many institutions, lecture-based instruction, e-learning materials, living anatomy models, radiological imaging and anatomy software are used in teaching surface anatomy; however, none of these methods proved to be effective over the others. Furthermore, some of these teaching resources lack clinical relevancy, possibly impeding students' appreciation on learning surface anatomy. Hence, integrating clinical input during surface anatomy teaching by involving patients in an actual clinical environment is pertinent. This article demonstrates the benefits and challenges of teaching surface anatomy in the clinical setting to medical students and highlights the need to design an evidence-based framework of work-based surface anatomy learning.

Keywords: Anatomy, Surface anatomy, Work-based learning, Clinical learning

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INTRODUCTION

Anatomy is an indisputably important knowledge that preclinical medical students need to master before entering the clinical phase (1). Knowledge on surface anatomy enables medical students and graduates to locate anatomical structures exteriorly, improve their clinical and procedural skills and interpret ultrasonographic and radiographic images (2). However, lack of attention is given on surface anatomy as compared to other areas in anatomy education (3-7). Indeed, it was argued that substandard surface anatomy knowledge has impaired the clinical capability of future doctors (7-10). Some medical schools do not even allocate a specific time slot for surface anatomy lecture. Instead, surface anatomy is frequently incorporated in a specific gross anatomy topic as one small learning outcome; as a result, it is covered didactically or during self-study by the students (11).

Cadaveric dissection class is generally less feasible because of various limitations in the medical curricula (12). Thus, students have limited opportunity to visualise and palpate anatomical landmarks on the cadavers (13). Moreover, the contact hours dedicated to surface anatomy education is also compressed as more time is spent on gross anatomy topics (14). Hence, it is pertinent to unearth the constructive way to endow medical students with adequate surface anatomy knowledge and skills acquisition for a safe clinical practice.

Currently, surface anatomy is commonly taught through lecture-based instruction, living anatomy, real-time ultrasound and anatomy software (2). Previous reviews highlighted that anatomy teaching is effective when taught through multimodal approach as this approach optimizes students' cognitive ability and psychomotor skills during the learning process (12,15). Contemporary strategies such as simulation, clinical correlation

instruction, peer-to-peer interaction, computer assisted- and problem based-learning was adopted to augment the conventional anatomy pedagogy (15,16). Although favoured by students, these methods are labour intensive, and some are even expensive. Hence, a practically relevant strategy in teaching is pertinent in the midst of inconsistencies in surface anatomy education (2,17).

Mastering the surface anatomy can be achieved through experiential learning (18,19). Experiential learning enforces learning by doing; here, students can have direct experiences of an academic setting, enabling them to gain cognitive knowledge, psychomotor skills and affective values (20,21). To teach effective surface anatomy using experiential learning, a clinical environment with supervision might be used instead of a classroom setting. Leveritt (7) reported that clinical year students and medical graduates perceived surface anatomy skill acquisition as an area of concern; thus, they recommend integrating surface anatomy topics to clinically applied elements. In fact, students have benefited from early clinical exposure, which does not only promote cognitive but also psychomotor and affective learning skills (22-25). Early exposure to the clinical learning environment presents horizontal and vertical integrations, whereby the basic surface anatomy is integrated with gross anatomy and clinical anatomy knowledge (26,27). To achieve integration, lecturers should teach surface anatomy in a contextualised clinical environment that involves patients in the wards and clinics (19). The work-based learning approach enables students to enhance their cognitive ability (understanding the basic gross anatomy and applying it in clinically relevant context), psychomotor ability (showcasing their skills in identifying the surface anatomy landmarks) and affective skills (interacting with patients, colleagues and other interprofessional health personnel). Furthermore, this innovative teaching strategy can address the problems related to the current methods of teaching surface anatomy.

Work-based learning is a learning strategy that exposes the learners to a true-to-life working environment (28). Hence, it provides a real-life experience for learning, whereby students can learn from real resources, which otherwise they will encounter only in their future working life (28). Work-based learning in medicine means learning in a clinical environment where students are required to learn directly from patients in the wards and clinics (29). This method is widely used by medical students in the clinical year who are required to perform case clerking, conduct physical examinations, interpret laboratory findings and radiographic images, plan patient management and perform ward rounds with the managing clinicians (30). In contrast, teaching and learning for preclinical students are confined within the lecture halls, tutorial rooms and laboratories because of limited access to the clinical environment (31,32).

Likewise, surface anatomy is often taught to preclinical medical students in classroom setting. Using advanced technology (e.g. anatomical software, online tools and radiological tools) for teaching surface anatomy is an interesting way to learn anatomy according to medical students (2,13). However, this method lacks two-way interaction, and its effectiveness in achieving learning outcomes has not been established (13,33,34). Therefore, hands-on activities such as body painting and peer physical examination are applied by many lecturers when teaching surface anatomy. The body painting method, which uses nontoxic paints, allows students to demarcate anatomical landmarks on their peers (35,36). Medical students find this method a fun activity that could stimulate self-directed learning (36,37). However, in any well-designed study, it could be argued that body painting has never been regarded as an efficient method in promoting knowledge acquisition and retention (36-38). Meanwhile, peer physical examination, which is a common teaching strategy for surface anatomy, has received various acceptability responses from the students. Some students might feel uncomfortable, embarrassed and anxious throughout the examination process when they allow themselves to be examined by their peers. This uncomfortable feeling could have been triggered by various factors, such as gender, age, religion and body appearance (2). This feeling might impose unnecessary stress, thereby hampering learning (39).

The knowledge acquisition and knowledge retention processes in students must transpire to achieve learning. The former refers to having solid understanding on the topic, whereas the latter refers to recalling the learned knowledge and applying it when performing a certain skill (40,41). Hence, finding an alternative method to surface anatomy teaching that is cost effective for knowledge acquisition and retention is important. Work-based learning is potentially effective in introducing surface anatomy to preclinical medical students because it allows active participation of students in performing physical examination (i.e. palpating bony prominences and delineating anatomical landmarks) on patients. Considering that they are examining a patient, students will be motivated to behave appropriately and learn about doctor–patient relationship, which includes obtaining patient's consent before physical examination, communicating effectively with the patient and acknowledging patient's rights and dignity during the examination (42). The students can also learn on how to build an effective teamwork and communication skills with the workplace stakeholders such as their peers, tutors and other healthcare workers who are involved in patient treatment and care (43). These professional behaviours, which are prerequisite for clinical practice, could be acquired during the preclinical phase of the curriculum by implementing work-based learning on surface anatomy (44).

Regarding psychomotor learning, the transfer of cognitive knowledge to skill acquisition can be improved through work-based learning. In fact, physical examination is a form of clinical application for surface anatomy knowledge (2). Application of knowledge during learning enhances knowledge retention (45,46). Compared to healthy subjects (as in peer examination), learning surface anatomy on a patient allows students to experience a different spectrum of learning scenarios. For instance, when learning surface anatomy of the abdomen, students may encounter a patient with a normal abdomen, enabling them to learn surface anatomy easily. Conversely, if the patient has ascites, students may face difficulty in identifying bony prominences and anatomical landmarks. Finding a way to correlate the normal surface anatomy with the abnormal condition would facilitate the development of cognitive skills (47). Surface anatomy learning can be achieved not only by performing physical examination on the patient but also by integrating it with procedural knowledge. For example, when attempting to place electrocardiogram's chest leads or during heart sound auscultation, students can learn the surface anatomy of the heart valves. However, the preclinical medical students may not be able to perform some invasive procedures (e.g. intravenous cannulation, venepuncture for blood sampling and chest tube insertion) during learning. Nonetheless, by observing and assisting medical doctors or senior medical students performing these procedures, the students could gain a new learning experience that can trigger reflection and self-study. Hence, a contextualised framework of the work-based surface anatomy learning for preclinical medical students must be developed to ensure successful implementation of the method. Figure 1 illustrates the conceptual link between work-based surface anatomy learning with effective surface anatomy education.

ISSUES AND CHALLENGES

Despite the foreseen benefits of the work-based learning for surface anatomy, some challenges may be faced when implementing this strategy as a formal teaching method; thus, proper planning is necessary before its execution (48). Firstly, preclinical medical students are novice learners in medical education. Hence, learning anatomy, which is a cognitively challenging subject,

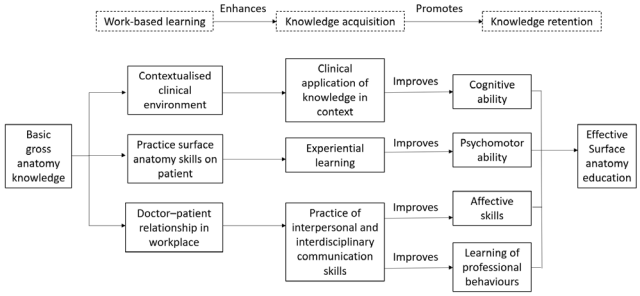

Figure 1: The conceptual framework of the work-based surface anatomy learning

might be difficult for them (49). Thus, before learning the surface anatomy of a structure, the students need to understand its gross anatomy to ensure smooth attainment of surface anatomy skills. Cognitive Load Theory (CLT) describes that learning could be optimised if teaching is aligned with human cognition (50). According to this instructional design theory, the presence of prior knowledge is an important determinant to reduce the cognitive load, which is pertinent to ensure learning (51). Hence, lecturers need to provide an introductory session as a guidance before the students attend the work-based learning for surface anatomy.

Secondly, preclinical year students are novice learners who have lack of exposure to clinical environment. Therefore, preclinical medical students could have minimal ability to embrace essential affective learning skills as part of the development of their professional behaviours. For instance, the students may not know how to properly approach patients to obtain a consent, communicate effectively and respect their decision. These skills are necessary to be learned continuously across the whole medical curriculum. Hence, anatomy lecturers need to be committed in providing work-based learning to sufficiently guide the students in acquiring surface anatomy and essential affective learning skills throughout the learning process. Having a tutor during a session would instil sense of receiving external support for learning, thereby reducing anxiety and fear of being exposed to a new learning environment (52). Even so, not all anatomy lecturers are qualified to guide the students in terms of patient–doctor relationship because a formal medical degree background is required. This requirement creates another problem to work-based learning for surface anatomy because many medical schools are facing with a shortage of anatomy lecturers, especially those who are equipped with a medical degree background (14,53).

Thirdly, some logistic problems may be encountered when implementing work-based learning for surface anatomy. Inclusion of preclinical medical students in this work-based learning may result in an excessive number of students, both preclinical and clinical year medical students, learning in the wards or clinics, causing an uncomfortable feeling for the hospital healthcare workers. The patients might also feel distressed because they have to entertain more examination requests from the students. The negative ambience of the learning environment could supress students' motivation to learn, thereby hampering their learning (54). The benefits and challenges in work-based surface anatomy learning are summarised in Table I.

TOWARDS THE DEVELOPMENT OF THE FRAMEWORK OF WORK-BASED LEARNING FOR SURFACE ANATOMY

To determine the success of work-based surface

Table I: Benefits and challenges of work-based surface anatomy learning to preclinical medical students

Benefits of work-based surface anatomy learning
• It allows clinical application in learning (2,45,46) • It provides opportunity for experiential learning (21-25) • It promotes active participation and engagement (28,29) • It promotes horizontal integration of anatomy knowledge (26,27) • It provides opportunity for contextualized learning (19) • It is a cost-effective learning method (2,13,33,34) • It is an adjunct teaching method that can overcome the limitation of the current method (35,36,39) • It promotes development of professional behavior (42,43,44) • It enhances psychomotor skill acquisition i.e. physical examination and procedural skill (47)
Challenges of work-based surface anatomy learning
• It is challenging to introduce work-based surface anatomy learning to novice preclinical medical student who lack of clinical exposure (49) • There is lack of anatomy lecturers with medical degree background who are qualified to conduct work-based surface anatomy teaching (14,53) • The clinical learning environment is not optimise to accommodate preclinical medical students' learning (i.e. excessive number of students in ward / clinic)

anatomy learning, lecturers should properly develop a solid framework of this teaching strategy before its implementation. The framework should incorporate solutions for the anticipated problems, which is supported by empirical evidence and principles of learning theories (55). Enhancing the cognitive ability, psychomotor skills and affective learning values of preclinical medical students should be the central tenet of the framework. Hence, multiple learning theories should be incorporated into its development.

Cognitive learning is the ability to acquire some knowledge and use such knowledge for storage, retention and transfer (51,56). According to CLT, knowledge acquisition happens when the human working memory has successfully processed the information that it received from the sensory memory, into an organised form of information known as schema. The schema is then stored in the long-term memory for future use (56,57). Learning would not occur when the information is not successfully processed into schema and is not transferred into long-term memory for storage (56). Several CLT-based instructional design strategies that could promote learning have been reported by empirical studies (58-61). Perhaps, this framework could adopt two CLT strategies, namely, stimulating students' prior knowledge and providing a worked example with a guidance-fading effect (58,62,63).

Conducting activities that can stimulate prior knowledge to learning helps the students retrieve the stored schema, which is used for subsequent schema construction (52). Through this strategy, the students have unknowingly reserved their working memory resources, which are limited, to retrieve the schema, given that the schema retrieval process is being physically integrated by the help of the lecturers (64). Hence, investing additional working memory resources for mental integration of the schema is unnecessary; rather, the reserved working memory resources can be used for processing new schema while learning the surface anatomy on patients (65). Prior knowledge is best instilled to students by teaching them firstly the relevant gross anatomy information before educating them on surface anatomy in the wards or clinics. Additionally, as novice learners, the preclinical medical students would benefit from learning worked examples, which is an organised sequential step in performing a learning task (66,67). Hence, before any hands-on activities, the lecturer needs to demonstrate the correct way of performing physical examination that is related to surface anatomy, as well as portraying professional behaviours as a medical doctor. Once the students have gained some knowledge and experience regarding the learning process, lecturers can now reduce guidance on the worked example by allowing them to conduct the first few steps of learning independently until they completely understand the topics. This strategy denotes the completion example effect and guidance-fading effects of the CLT (56). Learning through worked example, completion example and guidance-fading effects would reduce the students' cognitive load, facilitating their cognitive learning.

Moreover, work-based learning for surface anatomy is certainly a form of contextual learning that enforces the students to construct the meaning of the content that they have learned through their learning experience (55,68). In contextual learning, the acquired knowledge is transferred into the practical and social contexts, enabling the development of situated and social cognition (42). The process of knowledge transfer directs the students' mind to process the information by giving meaning and making sense of what they have learned in the classroom (68). Furthermore, understanding the connection between textbooks and the real-world increases students' engagement towards learning materials, leading to persistence, perseverance and successful transition of knowledge (20). Hence, the framework of work-based learning for surface anatomy should be integrated with various approaches of contextual learning to enrich the learning experience that can stimulate the development of knowledge, skills and affective value (19). Through multimodal teaching and learning activities, explicit roles of other healthcare providers through interprofessional collaboration and teamwork, learning enforcement through discovery and problem solving and provision of constructive feedbacks for improvement, this teaching strategy can be materialised (69). Consequently, students could normalise professional behaviours that they encounter in the ward and clinics (70).

One feasible way to fulfil the recommendation of these learning theories is by adopting the flipped classroom model for work-based surface anatomy learning. In the flipped classroom, students undergo pre–learning activities to stimulate their prior knowledge and go through various forms of learning modalities in the

wards. This approach promotes the students to be engaged in the learning activities in clinical setting, thereby enhancing skill mastery and behaviour change (71).

Although we believe that work-based learning is beneficial to preclinical medical student, there are significant issues and challenges to ensure its practicality and effectiveness. With this insight, educators should study on the relevant evidence of the pragmatic and productive approach of work-based surface anatomy teaching and learning. Therefore, further research is needed to explore the impact of work-based learning on the student's competencies of learning surface anatomy.

CONCLUSION

Teaching surface anatomy in the clinical setting is potentially effective because it can enhance the achievement of learning outcomes related to cognitive, psychomotor skill and affective domains. Early clinical exposure is beneficial in promoting learning, and this teaching method provides a platform for such early exposure to preclinical medical students. The gist of work-based learning for surface anatomy is to allow the students to learn through their experience. By providing meaning and sense to what they have experienced and observed in an actual clinical environment, these students would become more motivated and engaged to the learning process. However, work-based learning through surface anatomy should be designed according to evidence-based principles and learning theories; and its effectiveness should be explored in either authentic or simulated research environment. At present, the effectiveness of work-based learning for surface anatomy in boosting the knowledge, psychomotor skills and affective learning of students remains inconclusive.

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