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Structuring Quality Education by Proposing Physical Infrastructure of a Medical School

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ABSTRACT

Background: Due to cost containment considerations, it is common to have medical schools being located in buildings or campuses built for some other purposes. These buildings are converted into medical schools which often compromising the functional architectural aspects. **Objectives:** The paper examines, explores and proposes an architectural concept of a purpose-built medical school. The architectural design proposed is sensitive to the values and norms of many schools around the globe. **Methods:** An Internet search and personal communication were conducted, focusing on the concepts of the functionality of medical school. It emphasises on general design of the main building, keeping in mind the various kinds of teaching, learning and assessment activities. We examined lecture hall, pre-clinical laboratory, skill laboratory, general facilities of Objective Structured Practical Examination (OSPE) and Objective Structured Clinical Examination (OSCE). **Results:** We present hypothetical structural designs based on built-functions concepts. For example, for the better vision of students around a demonstration table, an inclined floor surface is proposed. The concept is as illustrated by anatomy dissection area built inclined upward from the cadaver table. It inevitably provides a better visual access to the students around the table. Other teaching and learning areas are also illustrated wherever appropriate in the text. **Conclusion:** The paper is hypothetical and explores innovative structural designs of modern medical schools. While most are built to meet the demands of current technology, it cannot however completely replace face-to-face teaching and learning processes. Research in architectural designs of education buildings and facilities may be further developed into a new research niche of medical education.

Keywords: *Architectural designs, Infrastructure, Medical school*

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Introduction

Technological advancement has enabled entrepreneurs, industrialists and educationists, to construct buildings of their choice, fulfilling the specific needs. Purpose-built structures enhance their management and hence productivity. In education, the combined articulated vision of the architects and teachers, on many occasions has created integrated teaching and learning solutions (1). Designing a medical school requires

both the skill of arts and sciences. Medical school buildings cannot be built based on the principle of "one size fits all" or having shop lots converted into a medical campus. Many campuses are built on newly purchased lands, usually in the form of a series of independent rectangular buildings, and are named after famous medical and/or national personalities. Aesthetic considerations often over-ride teaching and learning activities.

Accreditation of medical undergraduate programme requires structured teaching and learning components including curriculum, faculty and physical facilities such as lecture halls, laboratories, medical museum, clinical skill suits and teaching hospitals. There are collateral facilities and structures within the medical campus which are part and parcel of the smooth delivery of the curriculum and contribute towards the effectiveness of teaching and learning activities, but are never discussed or highlighted. There are many medical school buildings which have different sections built in isolation without being interlinked. It hinders the smooth teaching, learning and assessment activities.

This paper proposes an educational and architectural concept of a purpose-built medical school. The design focuses on curriculum delivery, learning and assessment. It emphasises on a faculty and student-friendly environment.

Method

The purpose built medical school is termed as **"FAST" Medical School.** The FAST concept focuses on the Faculty block (**F**), Assessment block (**A**), Student affairs block (**S**), and Teaching block (**T**) (Figure 1).

The teaching (T) and assessment block (A) are the pillars of FAST concept. Buildings may be joined at one tail or they could be parallel to each other. In cities where land is scarce, we suggest that the teaching and assessment blocks are built in a vertical multi-storeyed fashion and later extended

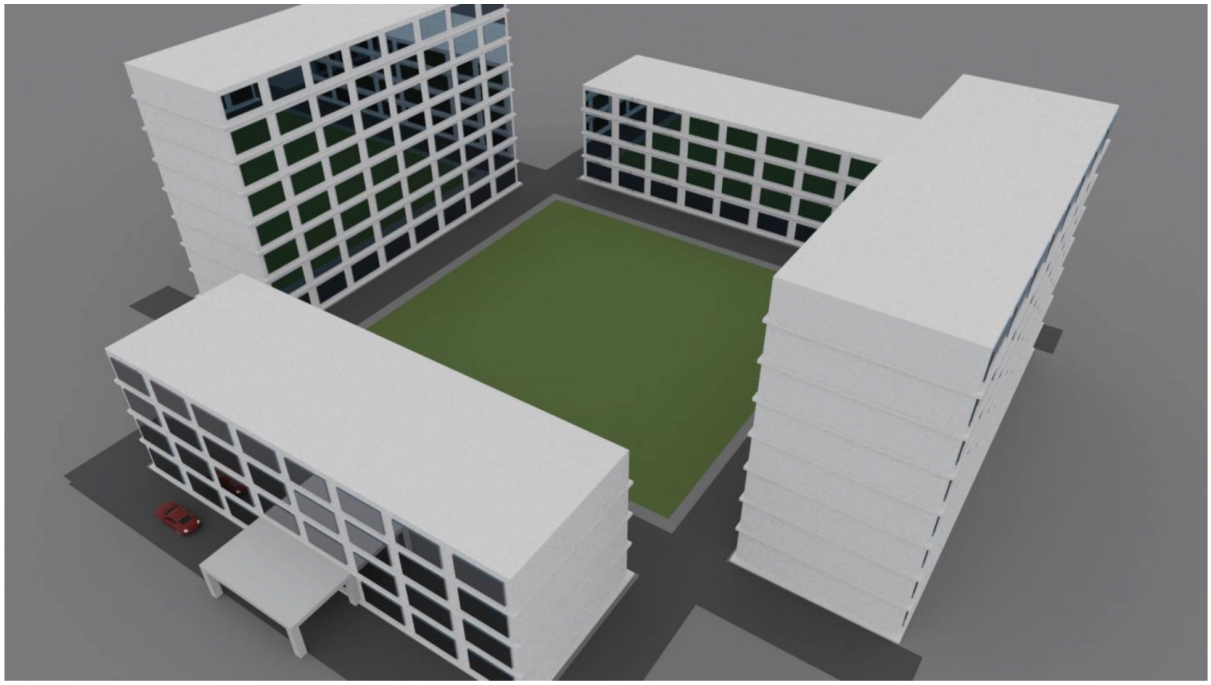

Figure 1: FAST Medical School.

Note: FAST Medical School consists of Faculty (F), Assessment (A), Student (S), and Teaching (T) blocks. The T and A blocks face each other and more likely linked at 1st or 2nd floor via a bridge (not shown in the Figure 1). The Block T is associated with curriculum delivery methods (360 degree lecture halls, practical labs etc. The Block A has separate Objective Structured Practical Examination (OSPE)/Objective Structured Clinical Examination (OSCE) halls.

horizontally according to the dictates of future needs.

The multi-storeyed teaching and assessment blocks include dissection hall, basic science laboratories, clinical skills labs, lecture halls, Problem based learning (PBL) rooms and library. Among these, the dissection hall, basic science lab, clinical skills lab, lecture hall have issues with on-going traditional infrastructure. In many medical schools, students having short or medium heights struggle for a clearer view during an on-going demonstration of dissection, in a hall with flat floor. Similar situation exists in the clinical skills labs and practical labs.

Highlights of FAST Medical School

Teaching (T) Block

The Dissection Hall

The dissection hall of FAST medical school is innovative; the floor rises gradually from the dissection table in the centre. The elevated floor enables the students to have a clear view of the cadaver (Figure 2a). The dissection hall is also made more user-friendly by having separate student observation area equipped with glass wall between them and the cadaver and equipped with IT facilities. This would allow students to observe the demonstration without having to smell formalin, while watching the dissection process on LCD screen (Figure 2b).

Pre-Clinical Laboratories

Pre-clinical laboratories serve for the practical sessions of pathology, microbiology, physiology, pharmacology and biochemistry. Many laboratories are not teacher-friendly and teachers often find it difficult to observe students while they are performing practical work. There are issues owing to the distance between teachers and students and having tables on flat floors of the labs. Instead of using traditional rectangular labs having flat floor surfaces, a FAST medical school has a 360 degree layout for the work stations.

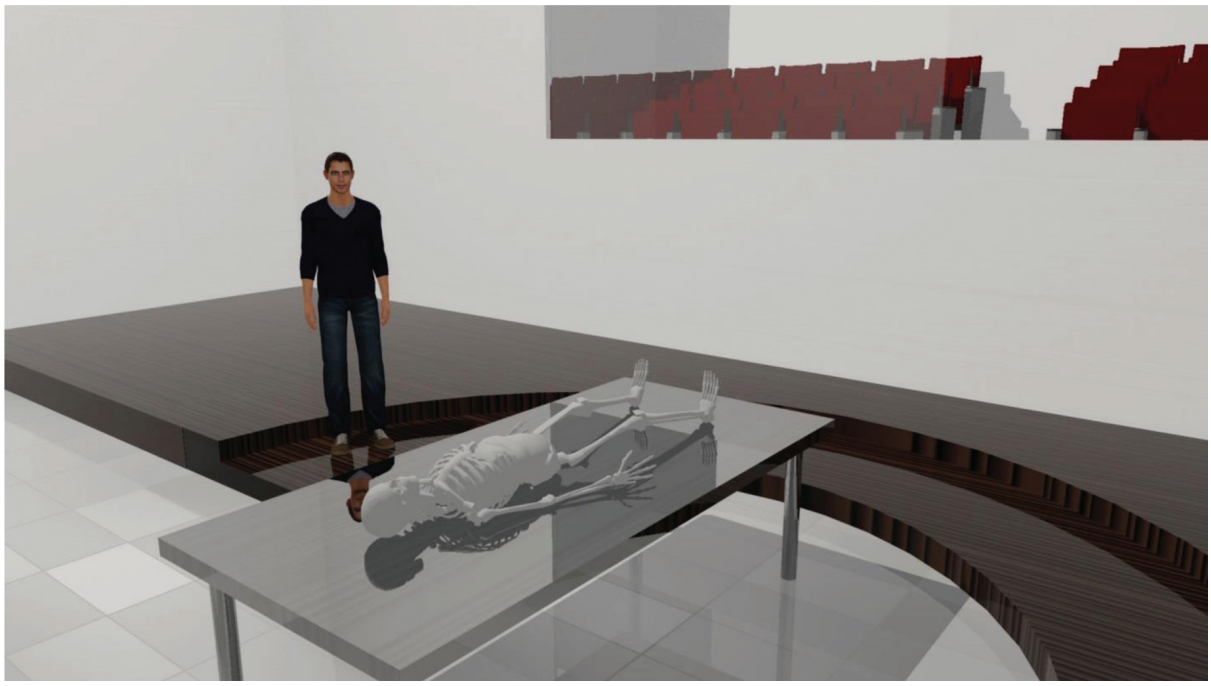

Figure 2a: Anatomy dissection hall.

Note: The floor of the dissection hall is NOT flat. It rises gradually from the cadaver table. Thus students can see clearly the cadaver due to their higher elevated position in respect of cadaver table.

Figure 2b: Anatomy dissection hall with glass window.

Note: Dissection hall of FAST medical school is user friendly by having separate "cadaver" and student observation area equipped with glass wall and IT facilities. It provides students to observe the demonstration without having smell of formalin and comfortably watching the process on LCD screen.

The working stations are arranged in 360 degree (circular). Having circle-shaped arrangement provides more space for students and brings students closer to their instructor. Projectors hang at head levels. The advantage is that instructors perform the experiment in the centre of the lab, which is easily visible directly and via LCD projectors. The other option is to divide the Pre-clinical lab into two sections; a demonstration area and the other as practice area (Figure 3a). Demonstration area is kept 30 degrees higher than the practice area. This will facilitate the teacher to have better observation of the students' practical work (Figure 3b).

Clinical Skill Laboratories

Clinical skill laboratories are divided into surgical-based and medical-based. The purpose is to provide pre-clinical psychomotor training on simulated scenarios. Such skills labs could also be used in clinical years to enhance and strengthen the psychomotor training of students.

Lecture Hall

Lecture hall has an inverse relationship with the class size and learning outcomes. Teachers in large classrooms have difficulty in getting to know their students, have minimal eye contact with them and often unable to understand their learning needs. All of these factors adversely affect students' performance (2).

The fundamental issue in most medical schools is of creating small-sized class of 200–250 students in a traditional lecture hall. In small-sized classroom such, a backbencher is 20–30 meters away from the lecturer. In order to bring the student closer to the teacher, a 360 degree lecture hall is proposed (3). In fact it is a circular flipped traditional lecture hall. The lecture hall would have four to six concave screens where the distance between the screen and the farthest viewer is not more than four times the screen width. Distance between the first row of seats and the screen is not less than twice the screen

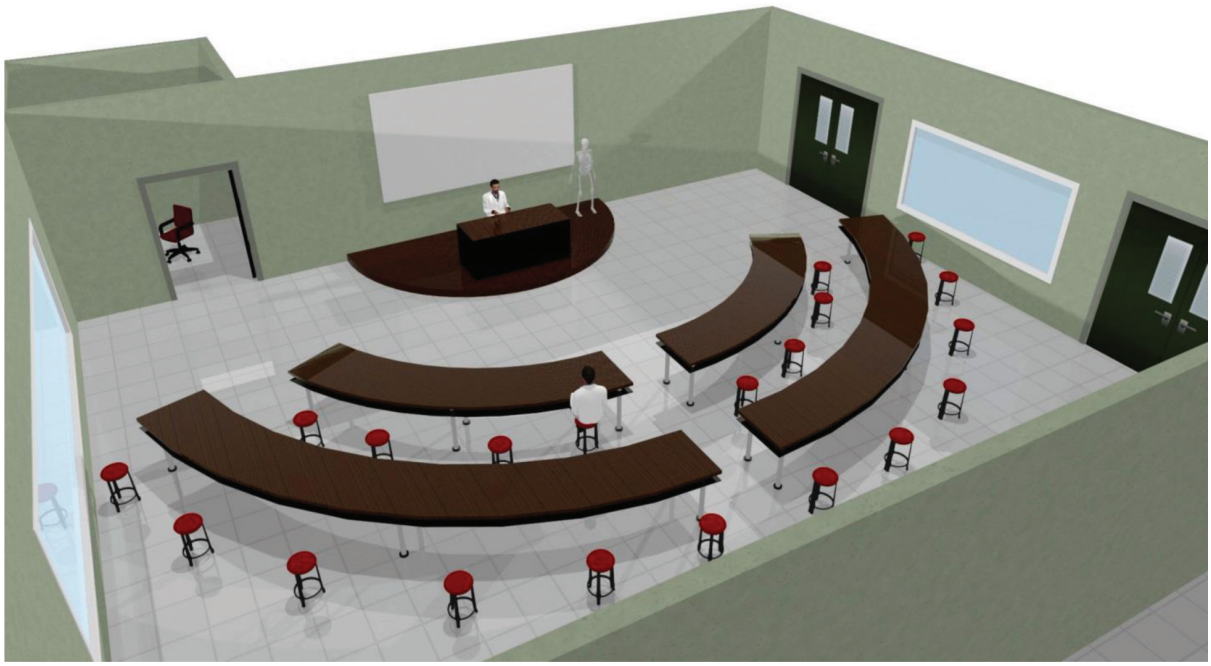

Figure 3a: Skill/Pre-clinical lab.

Note: The working stations of preclinical lab are arranged in 360 degree (circular) rather than rectangle shaped in FAST medical school. Having circle shape arrangement provides more space for students, and brings students closer to instructor. Projectors (not shown here) hang at head levels. The experiment performed by lecturer is visible to all students via LCD projectors.

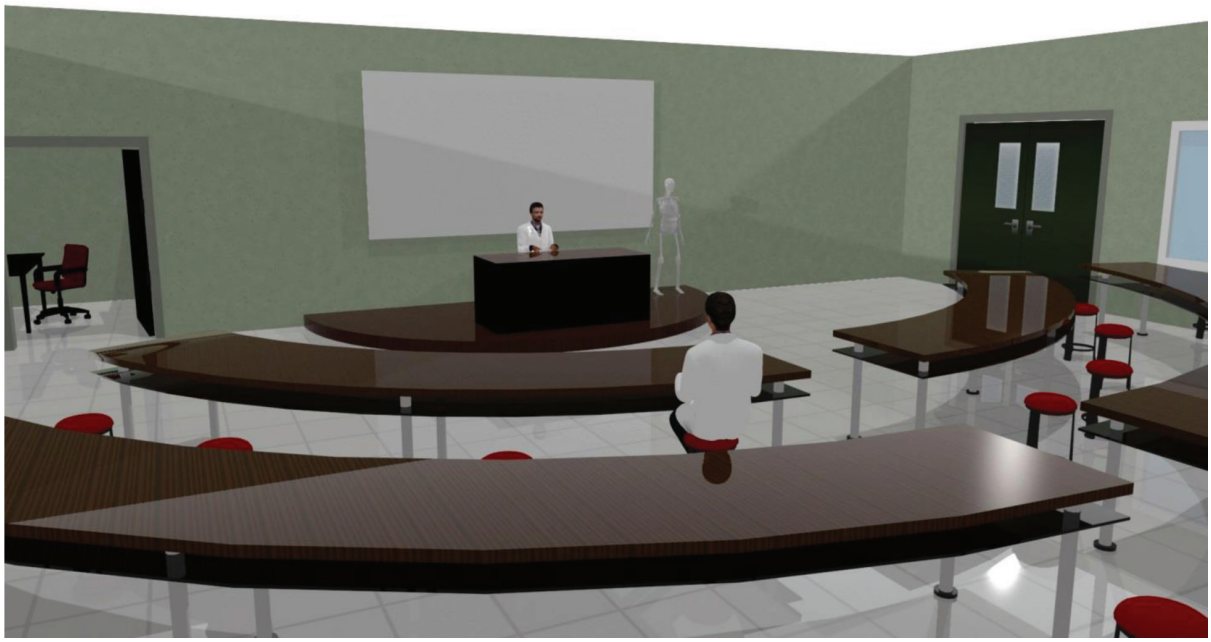

Figure 3b: Pre-clinical lab/skill lab.

Note: Pre-clinical lab/skill lab is divided into two sections; one demonstration area and a second practice area. Demonstration area is at a higher position (elevated at 30 degree in respect to practice area) to facilitate the observation of students' practical work.

width (4). In the middle of the lecture hall there is the station called as Source of Information (SOI). SOI is equipped with a round desk, microphone and other electronic devices. A key feature of SOI station is that it is fairly mobile, moving at a comfortable speed of around 0.025km/hr. and hence the teacher is able to see the students most of the time. In addition, counselling and e-library rooms are available close to the lecture hall. Students may use these as meeting place with their lecturers, or as resource centre.

Problem Based Learning (PBL) Rooms

Problem based learning (PBL) rooms are of three kinds in FAST medical school. These are PBL rooms for the 1st year, 2nd year, and the clinical years. Most medical schools have 50–60 PBL rooms; PBL sessions usually run simultaneously for different batches of students. In FAST PBL rooms, lecturers may or may not be with the students during PBL sessions; from Year 2 onwards, teachers use CCTV to monitor discussions of students. This method boosts students' confidence and help develops their communication skills. PBL room of clinical students are similar to the above but equipped with more electronic clinical resources and manikins, helping students build their clinical skills. PBL rooms could also be used for viva exam purposes.

Assessment (A) Block

The main components of "A" block are "Objective Structured Clinical/Practical Examination (OSCE/OSPE) halls", viva rooms, examination hall (written assessment), and answer script marking hall. The block has the car park in its basement which is strictly reserved for the academic/examination staff and students during the exam days. In many medical schools, car parking is a big problem especially those medical schools which are located in the densely populated big cities. In FAST medical school, having a car park in the same building would facilitate the assessment process and help to reduce the element of stress especially to students. This would provide a facility to park their vehicles at the same building where they are supposed to go for examination.

Objective Structured Clinical Examination (OSCE) Hall

Clinical assessment area has two OSCE halls and three quarantine rooms. The sequence of OSCE halls is shown Figure 4a. The architectural rule is two OSCE and three quarantine rooms (O2Q3). If the cohort is of ≥ 200 students, having two sets of them could be an option either on the same floor or two consecutive floors. The layout of OSCE hall with 24 rooms per (medical or surgical base) hall is shown in Figure 4b. The hall could be rectangular in shape. Ten rooms (five pairs) each on the north and south sides and four rooms (two rooms each in the east and west sides) would be furnished. Each OSCE hall could be divided horizontally by installing a partition/wall of such dimensions that the connection between different sides remains open. Putting a wall in the middle would provide additional space to accommodate more students in the OSCE (Figure 4b). The wall itself can be used during OSCE for

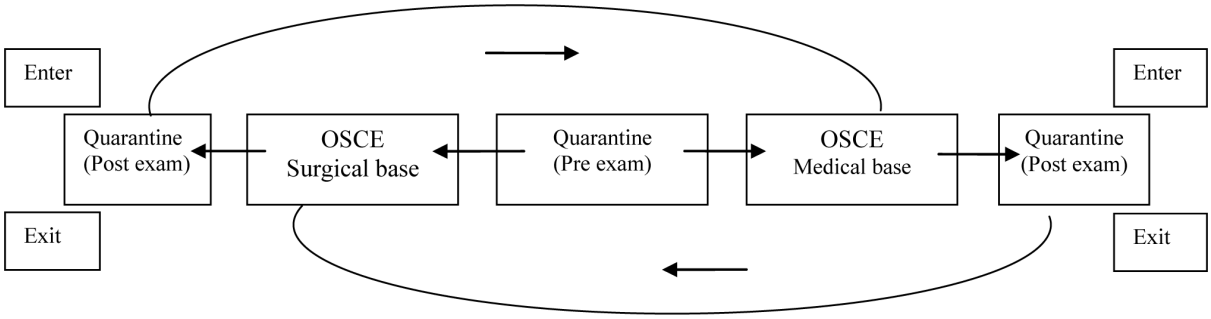

Figure 4a: O2Q3 Model for Objective Structured Clinical Examination (OSCE).

unmanned stations e.g., putting a radiograph or heart sounds on the computer or a specimen to be displayed.

OSCE rooms are used for assessment of clinical and soft skills. They must be sound proof and equipped with audio and video systems to facilitate the recording of the students' performance as well as examiners role. Purpose of recording students' performance in OSCE would further provide to re-assess the marking scheme or if a student appeals against any marking mistakes/concerns, the recording could be used as evidence.

The items such as tables, chairs, basins and hospital beds are to be provided in each OSCE station/room. Any other specific item required in the surgical or medical discipline may be provided or furnished at the time of planning of construction of OSCE hall. The OSCE rooms are arranged in pairs with a 3–5 feet gap which could be used either preparatory station for the next station or rest station. For example, in primary care, usually one station is the preparatory station where instructions are displayed and after reading those instructions; students have to perform in the next station.

Quarantine halls must be sound proof so that students in OSCE area are not disturbed by the noise of the ones using the quarantine hall. The O2Q3 area, other than being sound proof, must also be well-lit and properly ventilated. Quarantine halls should have portable lockers/cupboards to secure students' belongings (books, hand phones, lap tops, bags, notebooks, log books etc.) which students might bring as study aids before examination. After collecting students' belongings in a portable locker/cupboards could be moved from pre-exam quarantine to post-exam quarantine hall and handed over to them once they have finished their OSCE. Each quarantine hall should have a separate exit leading to outside.

Figure 4b: Sketch of Objective Structured Clinical Examination (OSCE) Hall.

Note: For clinical assessment in FAST medical school, there are two OSCE halls with three Quarantine rooms (O2Q3) as shown in Figure 4a. One OSCE hall accommodates surgical based OSCE stations and 2nd OSCE hall will have medical based OSCE stations. First students gather at Quarantine rooms located in the middle of two OSCE halls where they are given instructions about the OSCE and after that, students go to their respective hall. After finishing the OSCE, they are switched to other part of OSCE.

Each OSCE and Quarantine hall must have its independent washroom. Having this facility in O2Q3 setup would minimise the risk of mixing up of different sets of students hence the chances of academic misconduct are hindered.

Objective Structured Practical Examination (OSPE) Hall

The preferred location of OSPE hall is the first floor of assessment block. The rule is similar to OSCE i.e. two OSPE and three Quarantine halls (O2Q3) as shown in Figure 5a, which may be duplicated if the cohort is big as was mentioned for OSCE setup. OSPE stations could be arranged in a circular fashion or plus (+) shaped or S- shaped. It depends on decision of the planning committee. We suggest plus (+) -shaped arrangement of OSPE stations (Figure 5b). All requirements mentioned for OSCE hall would be maintained for OSPE hall.

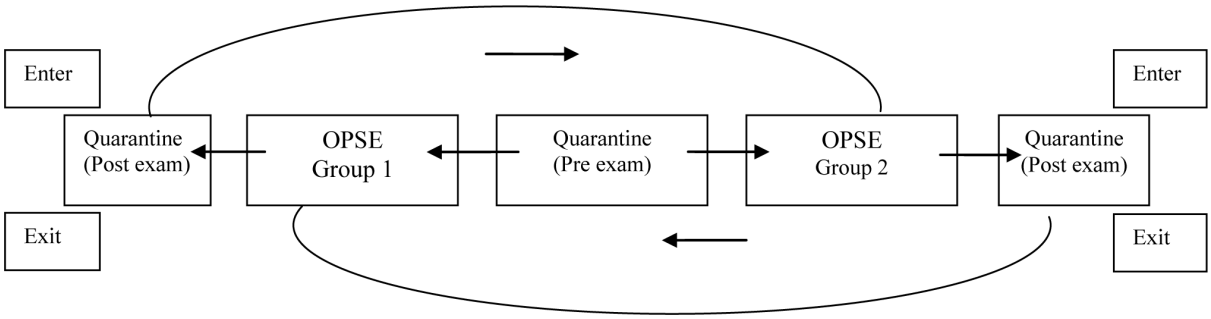

Figure 5a: O2Q3 Model for Objective Structured Practical Examination (OSPE)

Figure 5b: Inside of OSPE Hall.

Note: An OSPE hall has station arrangement in plus shape which are separated from each other with 3-5 feet gap as shown above. The OSPE hall is connected with two Quarantine halls at its each side which are sketched in Figure 5a. Stations will be equipped with required exam items and separated from each other and numbered consecutively for OSPE.

However, in order to help assessment or teaching activities, OSCE and OSPE halls must be connected with the skills labs and pre-clinical laboratories respectively. Their physical connection would facilitate the provision of items which could be missing or get faulty and an immediate replacement is required. We suggest OSCE and OSPE, skill lab and pre-clinical laboratories are parallel to each other at the same level of the teaching blocks. Having a physical connection at the same level would facilitate an easier and faster transport of items between the blocks.

Examination Hall

We propose a rectangular examination hall having an area of 250 × 400 square feet. It is similar to the examination halls of most medical schools. In addition however, it contains cabins or lockers at each corner to keep the books, mobiles and other accessories of students.

A distinguished feature of the exam hall of FAST medical school is that it has three stage areas; the one in front is relatively high e.g., four feet and the other two are on each side but at the same level as the hall. From a higher place, invigilators could observe all the students easily as compared to walking in between the rows where the students are seated.

The hall is sound proof and facilities such as lighting, air conditioning, heating; ventilation and sound system are provided adequately. Time display is furnished in the front, middle area of the sidewalls and at the back, so that it's equally visible from all directions. Washrooms (male and female) are located within the vicinity of the hall but separated and some distance away from the seating area. Other safety and security measures would also be in place.

Other than regular exit doors for students, there must be one exit for staff members involved in examination. This separate exit leads them to the elevators or stairs and would take them to the marking hall and examination paper printing hall, located just above the written examination hall. It would secure the integrity of answer scripts before and after the exam as well as during the process of their evaluation thus saving the hassles of any academic misconduct, loss of answer scripts or time.

Answer Script Marking and Paper Printing Block

This hall is just above the written examination hall and this facilitates the safety of examination related items. In most medical schools, there is no script marking room. Usually the answer scripts are marked by the lecturers in their office rooms. Sometimes students also visit them which make it relatively unsafe to keep the scripts in the lecturer's office.

In FAST medical school, we suggest a dedicated area for script marking and paper printing. Only concerned lecturers and staff members are allowed to enter into this area. Answer script area would be furnished with lockers and other security items. It is suggested that this area is also furnished with result area and the storage facility for safekeeping of the answer script after results are declared.

Faculty (F) Block

It would have medical education hall, question vetting rooms, staff development halls, meeting rooms in addition to offices of the dean and deputy dean/head of departments and rooms (space) for lecturers, auditorium, cafeteria and prayer room. The ground floor of "F" block would accommodate main meeting room, auditorium and visiting professor rooms.

Vetting Rooms

It is one of the primary components of "F" block. It should be–away from the staff area where students are not allowed to enter. It must be sound proof and isolated from teaching learning activities. We suggest 2–4 vetting rooms having a capacity to accommodate 5–8 people. It may be similar

to small meeting room shown in the design. A small meeting room may be used for the purpose of vetting provided it's away from student activity area.

Meeting Room

Main meeting room will have D-shaped seating arrangement, with a capacity to occupy 200–250 staff members. Seating arrangement would expand in stepladder pattern and every consecutive row will be 2–4 inches higher/wider/bigger from the respective row. The chairperson's seat will be at the higher row making it easier to see all the participants. Projector screens would be installed at all four sides to display the agenda of the meeting.

The suggested design for medium-sized meeting room is to be in a wedge/triangular shape where base (broader part) heads towards is allocated for the chair person and all of those participating converge towards at the end. This enhances the vision of chairperson so that he/she could see all persons. This kind of meeting room is located near to the medical education unit and is feasible for interdepartmental meetings.

Medical Education Hall

Medical education hall can be divided into curriculum and related accreditation documents. Its location is near to the medium-sized meeting room. There are faculty development/training auditorium near this area.

Students (S) Block

All departments associated with students' affairs are located in S block. It would include reception area, admission office, finance department, bank, marketing station, postal services, study lounge/library, locker rooms, restaurant and any other department required for the students for their teaching and learning activities.

In addition to the (building) of a medical school, other factors which play key role in enhancing the teaching and assessment of the students such as insulation from mechanical system noise, utility boxes, fire safety, accessibility routes, environmental issues, lighting, air conditioning, heating ventilation (especially in countries where there is long winter), telecommunication, audio-visual, technology, projection screens should be settled well and according to the specified standards and needs. Other than these, we suggest to have a guest house in FAST medical school which could accommodate 4–8 persons (external examiners for assessment during professional examinations). Many medical schools either do not invite or invite less numbers of external examiners because they have to bear their hotel accommodation expanses which are costly. Being located within the vicinity of medical school would make the assessment process easier, faster and cost effective.

Discussion

The physical environment significantly affects students' achievements as indicated by Earthman (5). Students spend a significant time in their schools, and the environment inevitably influences their education. Student-friendly and agreeable designs of schools foster a sense of belonging to the community (5). There is a strong need to create school designs in such a way that students would like to go there and spend a considerable part of their day in a comfortable and enjoyable way. The pleasant feeling of going to the campus should be somewhat similar to the way cafes attract people, rather than the space being purely functional and methodical but not attractive. Decent infrastructures contribute significantly in the effective delivery of the curriculum. A direct relationship is found between architecture and ambiance of schools and the quality of teachers' work. A friendly architecture has immediate and far reaching consequences on teachers' ability to effectively and efficiently accomplish their daily activities. Higgins et al. (1) suggested that less attentive and less successful students were particularly affected by the desk type

arrangement. Their on-task behaviour improved significantly when seated in rows instead of tables.

The medical schools for today and future require buildings to facilitate multidisciplinary instruction and interaction atmosphere. The altered architecture not only improves the academic, but also the social experience, which may play an important role in improving student retention rates. The future requirements and expectations reflect into creating structures for informal social and academic interaction. Sometimes medical school staff and students demand an architecture that reflects the pride and prestige of the institution and also fulfils the green standards of resource conservation (6). The healthcare architecture demands taking into consideration of both the construction and experience of buildings based on its purpose and everyday usage (7).

Well-designed lecture halls do not happen by chance. There is need of a positive and flexible attitude among the faculty members, especially those who are involved in the administrative matters as well, to foster the idea that making the lecture halls and laboratories more pleasant and student-friendly are the responsibility of everyone on board. U-shaped lecture hall is a minor variation of the traditional rectangular lecture halls. It provides the opportunity to majority of the students to face towards the instructor. In addition, it gives more space to the students in the middle of the hall to walk and come closer to the instructor if needed e.g., for discussion with instructor after the lecture. Semi D-shaped is another modified lecture hall and has been introduced currently in some medical schools. This design is an effort to bringing or providing maximum opportunity to students to be closer to the instructor. But what would happen if the cohort is composed of 250–300 students, which is a common scenario in many Asian medical schools. Many studies have proven that small-sized classes produce better results in terms of the academic achievements of students.

Many schools use clinical skill suites and pre-clinical laboratories as OSCE or OSPE centers respectively. They conduct classes in these laboratories and also conduct the examination in same area. During regular conduct of classes, items such as the specimens, instruments and manikins could be lost, damaged or become faulty. They need to be replaced or repaired but this process in many schools take a long time. As a result, during examination, the required items are not available because they are not repaired on time. We suggest in FAST medical school, each OSCE and OSPE hall must be equipped with items on which the students are supposed to be assessed. It means OSCE and OSPE halls must have separate set of items for assessment, which are also available to the clinical skills and pre-clinical laboratories at all times for teaching purposes.

Teaching learning experience can be expanded by having an open mind for innovations. The new ideas might be about improving the building styles and/or having access to better or upgraded technology. The goal is to make the educational experience more pleasant and meaningful for the students and faculty simultaneously. The University of Warwick has established an outreach centre known as the Leamington Spa Orthodontic Centre, seven miles from its main campus. This distant learning centre has a fully equipped lecture suite seating up to 30 students. All types of clinical procedures from the surgery or clinical skills laboratory will be delivered to the lecture theatre via camera/video link. The video-conferencing facility allows off site links to other similar facilities worldwide from The University of Warwick. This model can be applied not only to reach out to greater number of students in different parts of the world, but also is an example of how the established institutions may open up their doors to those who may not be able to physically join the course, just by getting more technically advanced and having small classrooms globally.

Medical literature has been documenting an increasing need for students to learn, practice

and demonstrate competence in basic clinical knowledge and skills. The Louisiana State University Health Science Centers (LSUHSC), School of Medicine, New Orleans replaced its traditional course theme with the Science and Practice of Medicine (SPM) course. The main component of the SPM course was the establishment of Clinical Skills Lab (CSL). The LSU-New Orleans faculty accomplished this task by the construction of a state-of-the-art school-wide learning center in 2001. The purpose of having a new structure was not to replace the real interactions with patients or to achieve mastery of clinical skills and procedures. The main focus was to develop the students' confidence in performing fundamental clinical skills starting from the first year until the completion of their course. This facilitated the students to get engaged in the acquisition of knowledge, technical and non-technical skills and professionalism from the beginning of medical school (8). The demands on professional practice and delivery of healthcare services are constantly changing dramatically. The high level of expectations from the professionals along with the increasing accreditation requirements will hold a strong grip on the way medical students, graduates, and other healthcare providers are educated and trained initially and throughout their careers. If the current situation does not allow for a bigger change, the management and faculty jointly may be able to suggest changes or improvements on a minor scale initially. Such small steps forward often pave way for more modern ways of improving the educational experience later on a larger scale.

Conclusion

The model described above is proposed and targeted at the management of upcoming medical schools. We do not mean to encourage that the existing medical schools be replaced by this type of arrangement. This paper suggests that the future medical schools and the certification boards may need to take into consideration of the architectural functionality of the building design in order to ensure its optimal usefulness and effectiveness in the process of academic delivery. The concept may be extended to other faculties as well e.g., schools for other health sciences, engineering school etc. Educational institutions need to have facilities which must accommodate smooth teaching, learning and assessment activities.

Acknowledgements

The authors would like to dedicate this school design and concepts to Muhammad Akram Arshad, Nazir Begum and Aftab Akram. It is extended also to medical education professionals and teachers of medical institutions.

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