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Can Traditional Teaching of Anatomy be Replaced by Alternative methods

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Abstract

Introduction: There is murmur in the management of medical colleges that traditional teaching of Anatomy is in the process of being replaced by alternative method. Therefore, besides literature survey, a feedback survey has been carried out to seek the viewpoints of students and faculties, through a questionnaire, to compare their viewpoints regarding Anatomy teaching by traditional and alternative methods. Aim of the study is to assess whether traditional teaching of Anatomy can be replaced by alternative methods.

Methods: A questionnaire having 17 questions, is designed to seek the feedback from medical students and faculties to assess the degree of need of traditional teaching of Anatomy in relation to comprehending medical subjects and for safe and successful clinical practice. The degree of need of traditional teaching of Anatomy is conceived such that if the mean responses of subjects fall within 9-17, it is most essential and cannot be replaced and if the responses lie within 0-8, it is not essential so can be replaced by alternative methods. The mean viewpoints have been computed and weighted mean is also calculated to compensate differential knowledge and experience of the subjects.

Results: Statistical analyses of mean viewpoints and weighted mean viewpoints of 100% medical students and faculties have been found in the range of 10.7±3.3 to 14.5±1.9. The weighted mean of the total population has been computed to be 13.23.

Conclusion: The teaching of Anatomy by traditional method is concluded most essential so it cannot be replaced by alternative method.

Keywords: Traditional teaching of Anatomy, viewpoints of students and faculties, Anatomy and clinical practice, replacement of anatomical teaching

Introduction

The objective of the medical education and profession is to relieve discomforts of the human body due to diseases expressed by signs and symptoms. The signs and symptoms of discomforts are generated by impairment of functions and activities due to distortions or variations in shapes, sizes, locations, orientations, configurations and pathways of macro/microstructures of organs and systems of the human body [1]. Distortions or variations, in turn, are produced by toxins, drugs, environmental hazards, pathogens, external traumas/internal lesions due to iatrogenic cau ses, misuse of organs/limbs, and/or congenital anomalies in the human body [2].

Thus, to relieve discomforts of disease, the distorted anatomical structures are to be identified, interpreted for degree of injury/distortions and restored by either

surgical or medicinal treatment. Consequently, *the diagnosis and analysis of treatment require thorough knowledge of Anatomy pertaining to normal and distorted structures [3]* because anatomical structures are distorted by disease processes but Radiology is equally important for image interpretation related to injury or distortion with the help of sound knowledge of Anatomy. The delivery of the clear concept of Anatomy depends on teaching methodology besides other factors. Various methods of teaching have been advocated by various scientists [3, 4, 5, 6, 7, 8] in literature to cultivate sound knowledge of Anatomy among the medical trainees. Out of these, most prevalent and relevant is updated traditional teaching of Anatomy [3] consisting of cadaver dissection as chief component in association with models, charts and other interactive internet based digital or other storage devices. But there is silent murmur that the alternative methods of teaching by prosections, charts, models etc., are intended to replace the updated traditional teaching of Anatomy (TTA).

It is therefore, important to compare the teaching of Anatomy by alternative methods. There are two methods of comparison, 1. By analyzing the delivery theoretically through review of literature and 2. by seeking feedback from the stakeholders (students, faculties/clinicians). Therefore, theoretically, the literature review has been planned together with a feedback survey seeking the opinion of students and faculties/clinicians to compare the delivery and acquisition of sufficient anatomy by both TTA and the alternative methods. Therefore, aim of study is whether the TTA can be replaced by alternative methods of teaching or not.

Material and methods:

The literature review has been conducted to compare the two methods of teaching and

the feedback survey has also been carried out on a total population of 667 subjects, consisting of 406 undergraduates (UGs), 16 Interns, 108 postgraduates (PGs, Specialties), 20 Post PGs (P PGs, Super-specialty), 54 Non-Clinical Faculties (NCFs) and 64 Clinical Faculties (CF**s**), all from U P University of Medical Sciences, Saifai Etawah U P India. A questionnaire, consisting of 17 questions focused on the comparison of degree of need of teaching Anatomy by the TTA or by alternative methods, was prepared and the views of the above populations were sought during August to November 2020. The questions were designed so that these populations could answer them by checking one option out of two from the questionnaires. Such as, A. Whether the physical examination of the patient can be carried out efficiently on the basis of teaching by piecemeal prosections or by TTA through comparison of knowledge of integrated cadaver with patient ‘s body. Yes or No. The questions aimed to ascertain the requirement of delivery of sufficient Anatomy for safe clinical practice during diagnosis and analysis of treatment together with a comparative analysis of teaching by TTA and by alternative methods of teaching for example, B. Whether the complete integrated anatomy of the body can better be realized by TTA method of teaching or by alternative methods. 1. TTA, 2. Alternative methods. C. Which method of teaching will be more helpful in analyzing the interlinked interrelation of functions and activities of body structures, organs and systems that are likely to be impaired due to anatomical distortions responsible for disease. 1. TTA, 2. Alternative methods.

There are 17 such questions. The answers (viewpoints) were calibrated to gauge the degree of need for TTA for delivering sufficient Anatomy for safe clinical practice comparing with the delivery by alternative methods. Such as, a few questions appended below. D. Which method of teaching will better deliver the comprehension of interrelation of distortions in integrated body with impairment of function and signs and symptoms of disease. 1. TTA, 2. Alternative methods.

E. Which method of teaching will help in better understanding of shapes, sizes, locations, orientations, branching patterns, pathways and configurations of multitude of anatomical macro/microstructures in organs or systems in relation to aftereffects of systemic functions, and various metabolic and other processes required in diagnosis. 1. TTA, 2. Alternative methods etc.

The responses have been segregated and summed up and calibrated in favor of TTA for each individual. This provided a huge volume of data, too divergent to extract any meaningful inference about the varied populations. As a result, the mean viewpoints of groups of populations have been computed. To

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examine the divergence in viewpoints, the standard deviation and ranges have been calculated.

The objective of the study is to conclude, "If TTA is most essential (ME), it cannot be replaced by alternative methods conversely, if TTA is not **e**ssential (NE), it can be replaced by alternative method." Now the most essential condition has been defined by range of mean viewpoints (answers) in favor of TTA by subjects to fall between 9 to 17 (53%-100%) whereas not essential condition has been defined by range of mean viewpoints (answers) in favor of TTA by subjects to fall in the range from 0 to 8 (0%-47%). To elaborate this, *a linear distribution model of means ranging from 1-17 has been conceived creating two zones on this model* as defined above (Fig. 1). Thereafter, the computed mean viewpoints have been superimposed on above model to extract inference regarding TTA for being ME or NE as per above concept. These parameters have been presented in the model of distribution shown in Figure 1.

These viewpoints were then, statistically, analyzed by computing the means/averages of all the groups of subjects separately, and *weighted means of viewpoints of the total population to compensate for the differential knowledge of teaching outcomes were also computed.* Thus, varying values of mean viewpoints represent not only viewpoints of various populations regarding the degree of need of TTA for comprehension of Anatomy and the knowledge of demand, necessity, importance, usefulness and applicability of human anatomy in clinical practice but also, comparative teaching outcomes by both the methods. This mean analysis has centralized the divergent viewpoints.

It is pertinent to mention here that, in calculating the mean viewpoints of these subjects, the knowledge and experience in corresponding fields has been considered equally important. However, it is known that their answers will definitely be influenced by their knowledge and experience, *so weighted means of the viewpoints of the total population have also been computed to compensate variability* of viewpoints. For this analysis, appropriate weights, depending on knowledge and experience of subjects, have been assigned as follows.

All the groups were classified into three classes/categories based on knowledge and experience of all the members of the groups. The UGs were categorized in Class 1 although UGs have varied knowledge and experience depending on their year of study. The NCFs along with the PGs including Interns have been kept in Class 2 although it is acknowledged that each group has a different kind of background. The CFs together with P PGs (SRs doing super-specialization) were categorized in Class 3. The Class 1 population, having limited exposure, was given a weightage of 50% (0.5). The class 2 population, with a distant knowledge and experience of degree of need of Anatomy teaching by TTA or alternative methods, was assigned a 75% (0.75) weightage. Class 3, with thorough knowledge and experience in clinical practice/teaching in relation to need and delivery of Anatomy by TTA or alternative method, was given 100% weightage.

Having computed mean and weighted mean, the mean values have been examined to determine whether these viewpoints lead to 'most essential' or 'not essential' for extracting inference. To explain the anomalous results, we also carried out divergence analysis for variability.

The degree of need of TTA has further been analyzed by *computing the percentages of participants from various group populations who supported most essential or not essential degree of need of TTA for teaching Anatomy to further strengthen our inference. Then, percentages of questions answered or not have also been calculated.*

Results:

Literature survey outcome: The literature survey reveals that updated TTA as described by Kumar and Singh [3], brings out that updated TTA is much superior to alternative methods as depicted in the table 1. The outcome of comparison brings out the superiority of TTA method over alternative methods. The level of delivery and/or acquisition of Anatomy by TTA and alternative methods have been clearly brought out showing superiority of TTA method.

Feedback survey outcome: All the questionnaires were evaluated based on model suggested in Materials and Methods section. The entire data from each individual of all the group populations was segregated and calibrated into category of 'most essential' higher means/percentages of answers in favor of TTA and 'not essential' lower means/

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percentages of answers in favor of TTA. The percentages of responders in favor of TTA is very high in ME category and low in NE including analysis of answered (very high) and not answered (very low) questions has also been carried out. These parameters were tabulated and statistically analyzed for comparison on theoretical scale and actually obtained from questionnaire answers. The results of statistical analysis are appended below.

Outcomes of statistical analysis 1: *Table 2 displays the mean viewpoints and standard deviations of UGs, Interns, PGs, NCFs, P PGs and CFs on the degree of need of teaching anatomy by TTA*. The values of the mean viewpoints of all the groups and the total population are in the range, 10.7±3.3 to 14.5±1.9 (Table 2).

The standard deviation being the measure of deviation is largest in UGs (3.3) and smallest in CFs (1.9). The deviation for other groups lies in between these values. The *range of answers* (viewpoints) of UGs is 3 to 16 which has largest span having widest variation of 13 and *least spread range* has been observed in the *viewpoints of NCFs* (9-17) with smallest variation equal to 8. All other ranges have been found in between these values (Table 2**)**. The *largest range of deviations* in mean viewpoints' value of UGs is -5.3 to 7.7. The *smallest range of deviation* in value of mean viewpoints of NCFs has been observed amounting to -3.5 to 4.5.

Thereafter, a linear distribution model (Fig. 1) on the basis of definition (given in material and methods section) of scale in the range (1-17) of mean viewpoints on degree of need of TTA for teaching of Anatomy was evolved. Then the actual mean viewpoints ranging from UGs=10.7 through Interns=14.4, PGs=13.3, P PGs=13.4, NCFs=13.5 and CFs=14.5, obtained from our computation, were superimposed to compare their status of degree of need. It *brought out that mean viewpoints of all populations occupy the central part of linear distribution model* in the range (9-17) defined for TTA to be 'most essential' (Fig. 1).

Lowest 72.2% of the UG participants extended their views to be most essential for TTA whereas 27.8% of these participants expressed their views that TTA is not essential in teaching of Anatomy. At the same time, 100% of NCF responders expressed their views that TTA is most essential in teaching of Anatomy (Fig. 2). The percent viewpoints of all other participants from remaining groups i.e. Interns, PGs, P PGS and CFs are 93.8 (~94) in favor and 6.2 (~6) against, 99.1 (~99) in favor and 0.9 (~1) against, 90 in favor and 10 against and 98.4 (~98) in favor and 1.6 (~2) against respectively Table 2.

The *percentages of answers*, of questionnaire given by participants of UGs, Interns, PGs, P PGS, NCFs and CFs, are 63%, 85%, 78%, 79%, 80%, and 85% respectively (Fig. 2). But 37%, 30%, 21%, 15%, 15%, 22% and 21% questions have not been answered by respective participants (Fig. 2).

Statistical analysis 2: *Table 3 shows the mean value of the viewpoints* of class 1equal to 10.7. In the case of class 2, the value is 13.5. For class 3, the value of mean viewpoints remains at 14.3. The value of the mean viewpoints of the total population is 11.9. Thereafter, weighted mean value of viewpoints of the total population has been found 13.23.

Discussion:

Importance of Anatomy in medical education and practice: The basic objective of medical education and practice is to maintain good health taking care of the human body. *Anatomy is the morphometric structural science of the human body, consisting of variations in normal shapes, sizes, locations, orientations, configurations and pathways of macro/microstructures of organs, limbs and systems of the body and its development from the zygote to complete body*. Thus, morbid Anatomy (Pathology), functional Anatomy (Physiology) [9], imagery of normal/distorted anatomical structures (Radiology), manipulation for restoration, removal and replacement of morbid anatomical structures (Surgery) and restoration, activation, dissolution of extra growth or other structures through drugs (Medicine) cannot be mastered in medical education without a thorough comprehension of Anatomy. But more than this, diagnosis is based on thorough physical examination by inspection, palpation, percussion and auscultation [10].

Then, using the outcome of logical and precise analysis and the mapping of signs and symptoms is carried out as asked in questionnaire- *Can the interrelation among the distortion, impairment of functions, signs and symptoms and disease be better understood by TTA through integrated cadaver or by*

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alternative methods? 1. TTA 2. Alternative methods. The degree of injury/distortion, in structure organ or system, is required not only for severity of disease to plan type of treatment but also its chronology for surgery. The opinion regarding this has been obtained by-*Can the images of distortions be interpreted without the knowledge of normal and distorted shapes?* In more complicated cases of surgery, it is advisable to carry out practice on cadaver before performing actual surgery. So, question has been framed as-*Can the exercise prior to surgery be performed on 1. cadaver or2. Alternative methods.* These reflect the interrelation among disease processes, distortions or variations of anatomical structures, and the impairment of functions of organs and systems [1]. *To accomplish this analysis, a knowledge of anatomical structure in relation to activities and functions is crucial to interrelate the impairment through distortion with signs and symptoms, and this is aided by the ability to identify distorted images by radiology*. Treatment follows these processes. Sound knowledge of sufficient Anatomy is 'most essential' and indispensable, not only in mastering medical education but in clinical practice. Besides these well-established observational inferences, many viewpoint surveys have revealed that Anatomy is highly useful in clinical practice and forms an integral part of medical education and practice [8, 11, 12, 13, 14].

Crisis of knowledge of Anatomy in medical education: *In spite of the fact that Anatomy is so important in medical education and practice, many future doctors have been found to have an inadequate knowledge of Anatomy* [8,11, 12, 13, 14]. This, in turn, is leading to a fall in the overall standard of medical practice [15]. The reasons for this have been attributed to ignoring and neglecting the teaching of Anatomy, due to rapidly declining resources and infrastructure facilities together with reduction in the time scheduled for anatomy in medical curricula [2,4, 6, 16, 17, 18, 19]. This trend is compounded by closure of dissection halls and Anatomy departments, and the lack of recruitment of experienced Anatomy faculty [20, 21, 22]. It has also been argued that, in addition, federal laws have been ignored in the USA, and GMC guidelines are not being followed in the UK [17, 20, 21].

Teaching methodologies of Anatomy in medical education: *Many researchers have suggested improvements in teaching methodologies to improve the acquisition/delivery of knowledge of Anatomy* [23]. Feigl and Sammer [19], Kumar and Singh [3], Pais et al., [24], Patra et al., [25] and Ramsey-Stewart [26] have carried out a very good study on model pedagogy of Anatomy, utilizing a blend of new and traditional teaching methodologies (updated traditional teaching of Anatomy) to improve the acquisition and delivery of anatomical knowledge. In another study, Singh et al., [27] looked at the development of Anatomy as a subject, aiming to transform the comprehension of medical education and thereby clinical practice in general and the knowledge of Anatomy in particular in future doctors.

Comparative analysis of TTA and alternative methods from literature review: As elaborated above, for safe and successful clinical practice the clear concept of Anatomy is most important. Therefore, it is pertinent to compare the delivery of anatomical knowledge by both methods. The comparison of two methods of teaching is a debatable and controversial issue. However, the table of comparison gives the glimpses of advantages/disadvantages of two methods of teaching providing a clue for TTA to be superior to alternative method (Table 1).

Cadaver dissection: The most important, in TTA, is study of Anatomy through cadaver dissection. The dissection is used in Anatomy teaching for over 400 years [28] providing value addition such as; thorough understanding, ability to apply in clinical practice, emboldening to face causalities, achieving experience of skill for surgery and understanding the relationship between patients' symptoms and pathology [28, 29]. It also develops professionalism, spirit of working together, stress management and empathy [30]. The cadaver dissection provides opportunity to detect more anatomical variations/anomalies [31] unlike plastination and preserve texture to a level close to those of living body which allow students to feel as if they are in the operating theatre [32].

Therefore, the dissection courses are still indispensable for learners to achieve anatomical knowledge [31]. Majority of anatomists (69%) advocated for dissection [33] together with Kerby et al., [34] and Davis et al., [35] rated/discovered that

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anatomists and medical students found dissection as fittest method to teach Anatomy.

The cadavers' color, texture and smell are different from real patient and they cannot be palpated, auscultated or usefully asked to change position [36]. On the other hand, the dissection is not only costly, time-consuming and outdated [36,3 7, 38, 39] but also, dissection is not being used in many medical schools in UK, US, and Australia [17, 39, 40]. The feel of touching the cadaver, incise the skin, and looking into the natural complexities of the body cannot be simulated perfectly. So, these newer technologies [25] can be used as an add on to visualize the anatomy of complex structures as elaborated by Kumar and Singh [3] also

Prosections: A prosection is an already dissected, sometimes plastinated specimen. Due to reduction in time schedule of Anatomy in medical education, prosections have been adopted as shortcut method to teach such a important subject like Anatomy which is indispensable not only to comprehend medical subjects but also to perform safe and successful clinical practice. The first medical school in UK namely, "The University of Warwick" adopted plastinated prosections to deliver Anatomy in 2009 [41]. Thereafter, other medical school including St George's (London, UK) and Nottingham University (UK) followed the que. 94% of students found plastinated prosections as a useful tool for their anatomical learning. The prosection based teaching is prevalent in 19 Australian and New Zealand medical schools [17]. However, the cumbersome and time-consuming process of preparing prosections by ample of skilled personal are a few constraints beside those explained in the table 1. *Furthermore, the medical trainees learned from prosection or plastination expressed that their anatomical knowledge is confusing and insufficient* [42]. The learning with plastinated prosections was perceived to be compromised because of limitations in terms of tactile and emotional experience. Still, some anatomists believe that prosections can replace full body dissection in teaching gross anatomy [43].

Medical imaging: The medical imaging is traditionally used during teaching Anatomy as an aid to clinical practice but teaching of Anatomy, exclusively, through imagery is constrained by the knowledge of normal and variant morphology and morphometry of shapes, sizes, locations, orientations, branching patterns, pathways and configurations of multitude of anatomical macro/microstructures in organs and systems derivable from teaching through cadaveric dissection. However as mentioned in a quote by author at the beginning, "*If imagery is the third eye of a clinician for investigating disease, Anatomy is his sixth sense to comprehend and analyze the disease and prescribe treatments. Without the sixth sense, neither eye can sense an image nor can record it. So, together Anatomy and Radiology contribute, divided they demolish*.", sent a crystal clearly message that Anatomy and Radiology are, not to speak of, complement to each other, rather both are used to analyze Anatomy of the body of patient. However, *images are images, but image cannot give a feeling of real*. Though the studies through cadaver dissection give morphology and morphometry of real structures yet these structures are different from patient's structures. But these are only sources of knowledge for clinical analysis. Therefore, to investigate the patient's disease, delivery of sound knowledge of both Anatomy and Radiology is essential.

It is pertinent to mention here that the clinical practice, fundamentally, depends on development of structures and their relation with daily activities and functions in relation to morphology and morphometry of real structures and complications through distortions by infections through pathogens, exposure to extreme environmental conditions, traumas and injuries, side-effects and iatrogenic injuries. Thus, distortions are root cause of diseases. These distortions are interrelated with cascading effect on other structures and processes running in human body. These things can only be diagnosed and manipulated by the knowledge accumulated from complete integrated human body and images of distorted structures. So, this entire knowledge derived from extrapolation and interpolation from cadavers to be applied to patient with the help of recorded and interpreted imagery of distorted structures. So, the radiological images are used in teaching of Anatomy to see *in vivo* visualization of anatomical structure and physiology as well as insight into pathological processes with the help of computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound to observe internal morphology in 2D and 3D and to interpret anatomically, the images in

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clinical context [44, 45, 46, 47, 48]. The brilliant and beautiful comments on the role of radiology and radiologist in anatomy teaching has been explicitly, brought out in an editorial [49].

Thus, the importance of imagery cannot be ignored as it helps to locate, identify, and interpret distortion [50, 51] but as regards teaching of Anatomy, be it, morphology and morphometry of normal/distorted structures, their configuration, their networks in entire body, systemic configuration, the development of structures/organs/systems and the use of histological study to see microstructures, is impossible. Medical imaging cannot substitute for the benefits of conventional dissection [37, 45, 52] as it has important limitations as a stand-alone approach. By denying students the opportunity to dissect, "the immediacy of the mortality of cadavers and patients is likely to be dissolved" [45]. Though clinical practice is based on the analytic knowledge of Anatomy but Radiology provide the structural changes inside the patient body which otherwise are not possible.

Live anatomy: This is more akin to Patient's Anatomy; therefore, this is more useful to calibrate the patient's body to locate the normal/distorted structures from the surface in respect of clinical findings. The live Anatomy unlike cadaver provide similar color, texture and smell like real patient.

Peer physical examination (PPE) involves students physically examining each other [53]. Some Students are willing some are not to participate in PPE [54]. The students learn physical examination in primary diagnosis before switching over to the patients together with empathy and interaction skill [55, 56]. This method of examination is frequently used in medical education [57]. Body painting in anatomy education refers to painting internal structures on the surface of the body using marker pens or wax crayons [58]. Body painting enhances retention and recall of anatomical knowledge [58, 59] and is very helpful in surface anatomy and clinical skills.

Interpretation of Statistical analysis:

Mean analysis: The outcome of mean analysis brings out that the means of viewpoints with standard deviation of all the group populations are in the range 10.7±3.3 to 14.5±1.9 where mean viewpoints of UGs are 10.7±3.3 at the lower end coupled 14.5±1.9 at higher end belonging to CFs. The rest of the groups expressed their viewpoints between these two extreme limits (Table 2). *All the mean viewpoints, from all the groups as shown above, lie well within the range of 'most essential', that is, between 9-17.*

Although mean viewpoints of group populations or of the total population present an average viewpoint of all the group members where some members of populations support TTA as most essential far more strongly than others. These variable viewpoints are present in the entire data. *Nevertheless, all the individual group populations and total population support 'most essential' degree of need of TTA, as the range of mean viewpoints (Table 2) of these groups and total population (mean=11.9) fall well within the range (9-17) defined as most essential.*

This is pertinent for explaining the divergence in the viewpoints of all the populations separately to answer certain hidden questions in the analysis. This data indicates that the mean viewpoints of UGs (10.7) is lowest, representing a lesser degree of need towards the lower end of the range of the most essential degree of need in the model coupled with the highest standard deviation, (3.3) showing largest divergence among all the group populations. In contrast, *the mean viewpoints of the CFs are highest (14.5) coupled with a minimum standard deviation (1.9).* This represents the lowest divergence in their viewpoints. It can also be seen from Table 2 that the weights assigned are logical qualified by knowledge and experience. This large divergence in the viewpoints of UGs can be seen from the range of answers/viewpoints, 3-16, for most essential degree of need of TTA. The variation in these answers is 16-3=13, the highest in all the population groups, whereas the lowest range and variation is among NCFs as 9-17 = 8. In addition to this, the range of minimum and maximum deviation in mean values is highest in UGs from -5.3 to 7.7, and lowest in NCFs from -3.5 to 4.5 (Table 2). These results may be attributed to the varied knowledge and experience of the students/faculties. As UG group consists of a spectrum of populations from fresh entrants in first year to second, third, and fourth, and final year of MBBS course. The first-year students may not have sufficient knowledge and experience to understand some of the questions. The UGs total population is largest (406) of all the groups (16, 108, 20, 53 and 64), so that the weighted mean could refine the

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outcome from 11.9 to 13.23. In addition to this, the University is situated in a completely rural area where they speak Hindi and the premedical medium of instruction, Hindi, so, they might have problem in understanding the questions in English.

Each responder was provided with a questionnaire consisting of 17 questions. Thus, total questions supplied to the responders were 11339. *Out of 667 participants, 549 subjects express their viewpoints for TTA being most essential whereas 118 subjects support TTA not essential for TTA*. Here, out of 118 subjects, 113 subjects belong to UG group. Only 5 out of 261 subjects from other groups accepts TTA not essential whereas *256 out of 261 support the view that TTA is most essential for anatomical teaching*. *However, all the mean values establish that the degree of need of TTA is most essential for anatomical teaching*.

The percentage analysis:

The *percentages of responders*, from various population groups for most essential degree of need of TTA, are 72.2% from UGs, 93.8% from Interns, 99.1% from PGs, 90% from P PGs, 100% from NCFs, 98.4% from CFs and 82% from the total population. This data has been analyzed in Figure 2. *Here, 72% to 100% of individual groups and total population accept that the degree of need of TTA is most essential* ***(****Fig. 2****),*** *whereas as few as 28% of UGs and 0% of NCFs, considered that TTA is not essential for anatomical teaching* (Fig. 2).

The percentage analysis of answers/viewpoints establishes that the *majority (82%) of subjects hold the viewpoint that TTA is most essential for the teaching of anatomy (*Fig. 2). This is shown by the following figures: UGs, 63%, interns 85%, PGs 78%, P PGS 79%, NCFs 80% and CFs 85% (Figure 2). It is pertinent to note that large numbers of some cohorts did not answer all the questions: 37% of UGs**,** 30% of the total population, 22% of PGs, 21% of both P PGs and NCFs, and 15% by CFs and Interns. These inferences reveal that UGs could not answer the largest number of questions of all the groups. This supports the conclusion that knowledge and experience play a vital role in answering the questionnaire. Moreover, the mean viewpoints of the total population at 11.9 demonstrates that 100% of participants are of the view that TTA is most essential for teaching of Anatomy.

Weighted Mean: The computation of weighted mean values has refined the mean viewpoints of the total population from 11.9 to 13.23, once again supporting the conclusion that TTA is most essential (Table 3).

The range 9-17 distribute the degree of need of TTA linearly, meaning thereby that the answer, 9 in favor, represent lowest degree of most essential need of TTA whereas 17 represents the highest degree of most essential need of TTA.

The mean viewpoints of the population groups, ranging from 10.7-14.5 represented by the green envelope for TTA being most essential in anatomical teaching, occupies the central part of the linear distribution model of 9-17 (Fig. 1). However, the mean viewpoints (10.7) of UGs lying in the lower part of this distribution curve indicate a lower degree of most essential, whereas the mean viewpoints (14.5) of CFs represent the uppermost value closer to 17, indicating a high degree of need of the teaching of anatomy by TTA (Figure 1). All other mean weighted values lie in the central area, further confirming that the degree of need of TTA is most essential.

Conclusions:

The feedback experiment carried out among medical students, and clinical and non-clinical faculties has established that need of teaching anatomy by traditional method emerges as most essential, Therefore, it cannot be satisfactorily replaced by the alternative method as defined in this study. The analysis of literature review though controversial yet TTA has been supported by majority of subjects at stake. The updated traditional teaching of Anatomy will further improve the acquisition and delivery of Anatomy for safe and successful clinical practice.

Limitations:

1. The chief limitation in this research was extremely variable inter/intragroup knowledge and experience of the various groups, not to speak of the total population influencing the mean and percentage analysis.

2. The varying degrees of knowledge of English also affected the subjects' answers in the questionnaire.

3. Some among the groups either had no, or very little, exposure to clinical practice.

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4. The Covid 19 pandemic interrupted the collection of data.

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Author Contribution:

1. R Singh: Protocol development, Data analysis, Manuscript writing
2. N Yadav: Data Collection
3. M Pandey: Data Collection
4. DG Jones: Critically reviewing/editing the manuscript

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Figure Legend:

Figure 1: Green curve, superimposed over the linear distribution model, envelops the most essential mean viewpoints for degree of need of TTA by all the group populations.; and pink curve covers not essential mean viewpoints 7 by UGs and P PGs and 8 by Interns, PGs, NCFs and CFs; Zone of responses for most essential (9-17) marked along vertical axis by green colour bounded by terminal lines in pink upper and orange lower. Whereas zone of responses for not essential (0-8) marked in red colour bounded by blue coloured upper limit and lower limit by axis.

ME=most essential, NE= not essential, UGs= undergraduate students, PGs=Post graduate students, PPGs=Post PGs, NCFs=Nonclinical faculty. CFs= Clinical faculty, TP= total population, Ints= interns TTA= Traditional teaching of Anatomy

Figure 2: Curve (1) represents percentage of responders expressing most essential degree of need for traditional teaching of Anatomy. Curve (2) represents percentage of questions answered by various groups, Curve (3) represents the questions not answered and Curve (4) percentage of responders expressing for not essential degree for traditional teaching of Anatomy.

%RME= Percentage of responders for most essential degree of need of traditional teaching of Anatomy, %RNE= Percentage of responders for not essential degree of need of traditional teaching of Anatomy, %Qs A= Percentage of questions answered, %QsNA= Percentage of questions not answered, Ugs= undergraduate students, PGs=Post graduate students, PPGs=Post PGs, NCFs=Nonclinical faculty. CFs= Clinical faculty, TP=total polpulation

Table legend:

Table 1

APs=Structures, Organs and Systems; EAPs= shapes, sizes, locations, orientations, branching patterns, pathways and configurations

Table 2

UGs= undergraduate students, PGs=Post graduate students, PPGs=Post PGs, NCFs=Nonclinical faculty. CFs= Clinical faculty, Pop.=Population, DNTTA= Degree of need of traditional teaching of Anatomy, SD=standard deviation, ME=most essential, NE=not essential, %=percentage, Dev.=deviation

Table 3

UGs= undergraduate students, PGs=Post graduate students, PPGs=Post PGs, NCFs=Nonclinical faculties. CFs= Clinical faculties, M=mean, %=percentage, DNTTA= Degree of need of traditional teaching of Anatomy, ME=most essential G P=Group population, WM= weighted mean

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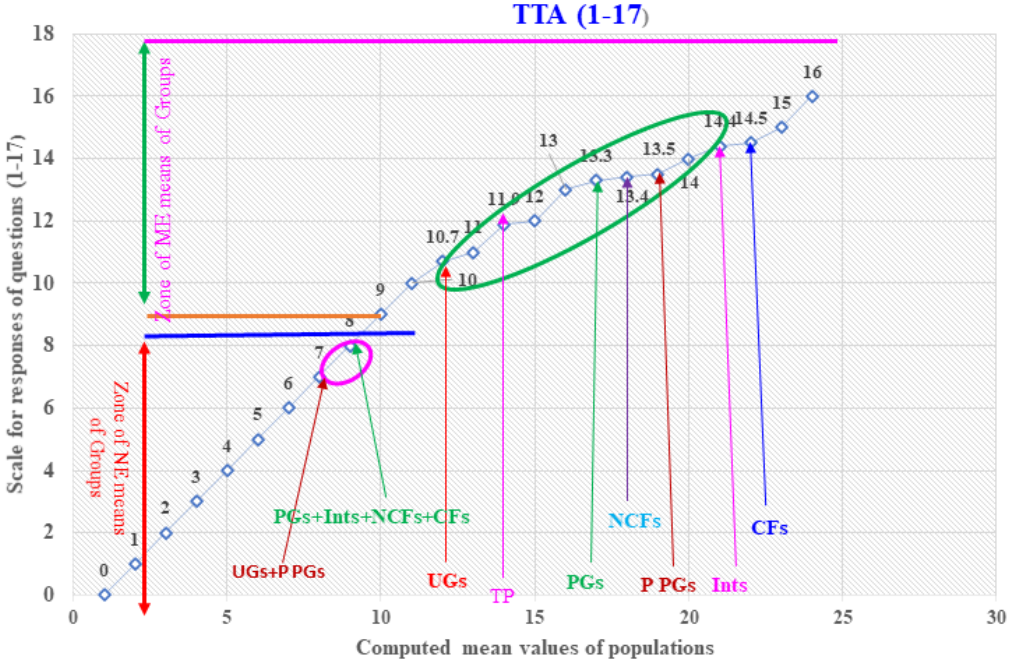
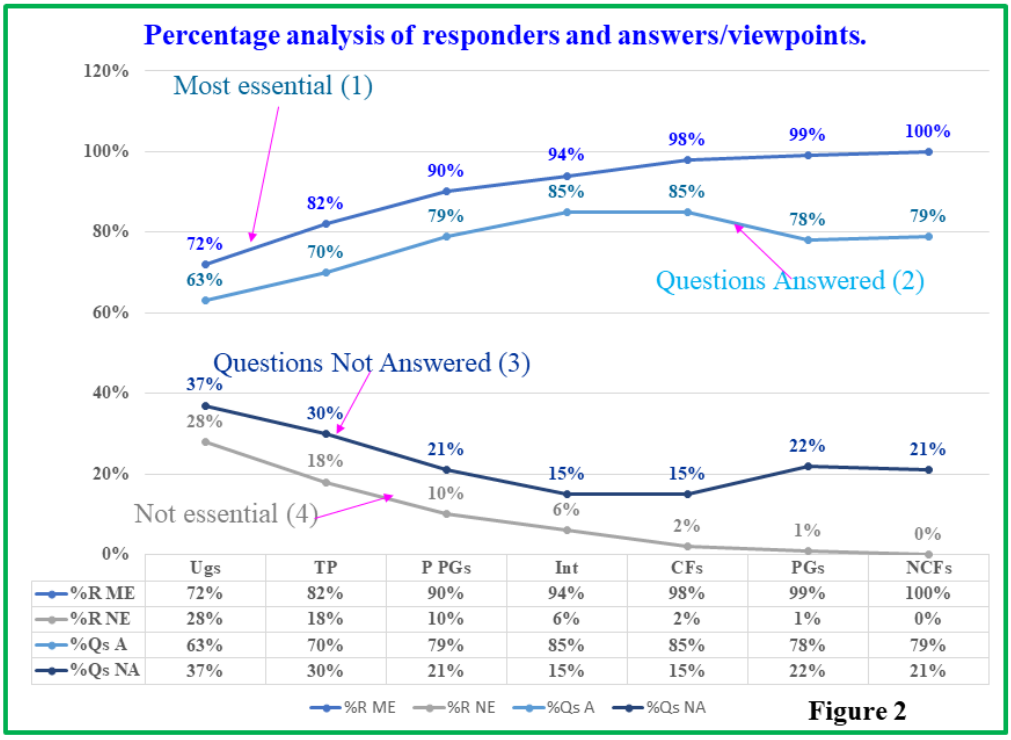


Figure 1



	Ugs	TP	P PGs	Int	CFs	PGs	NCFs
%R ME	72%	82%	90%	94%	98%	99%	100%
%R NE	28%	18%	10%	6%	2%	1%	0%
%Qs A	63%	70%	79%	85%	85%	78%	79%
%Qs NA	37%	30%	21%	15%	15%	22%	21%

Figure 2

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Table 1: Comparison of teaching by Traditional Teaching of Anatomy and Alternative method

Parameter	Traditional Teaching of Anatomy	Alternative method
Comprehension of configuration, APs and EAPs in complete body	The comprehension of EAPs of APs configured and separately wrt functions and activities by theoretical description and practical verification through integrated cadaveric dissection is always **better**.	The comprehension of EAPs of APs configured and separately by theoretical description and practical verification through alternative method are comparatively **low**.
Comprehension of complete organized human body	The feel of an integrated human body to be equated with patients' body is **easier**.	Through piecemeal prosections do not give **that feel**.
Interlinks and Interrelations of APs	Comprehension of practical interlinking and interrelationship of APs is **much better.**	Theoretically and by prosections and images is **not well understood**.
Systemic functions in complete human body	Integrated systemic Anatomy of body wrt functions is **clearly brought out**.	By alternative method the systemic functions are **not well cultivated**.
Morphology and Morphometry of APs and EAPs	The exact normal morphology and morphometry of APs wrt EAPs from landmarks is **clearly seen on cadavers**.	The morphology and morphometry of APs wrt EAPs by images/prosections remains **subjective**.
Morphology of microstructures	Estimation of morphology of Microstructures is **faithfully brought out** by histological slides.	**Subjective** microstructures beyond the resolution, influenced by artifacts and edge-effects in images.
Correlation of Patient's body with Anatomy	**One to one correlation** wrt landmarks from cadaver to patient's body	**Not straight**
Variations in APs and EAPs	**More variations** in EAPs of APs, APs	**Less variations** and subjective by images
Integrated functions and activities of human body	The cascading effects of distortions on systemic functioning, metabolic and other processes **can be understood** in cadavers	Theoretically and by **less effective** models and charts and images **cannot give a clear concept.**
Identification and interpretation	Identification of APs by EAPs, injuries/distortions in presence of variations **can be done more precisely**,	**Subjective** due to imagery limitations and piecemeal prosections.
Effect of locationally sensitive medicines and drugs in body processes	Integrated location dependent medicinal/drug analysis to avoid side-effects **can be done**.	Theoretically through models and charts **subjective**.
Confidence in surgery	**Real experience of access path/surgery**	**Not possible**

Table 2: Shows Statistical mean analysis of group population

Groups of Pop.	Mean ± SD	**D N TTA**	Responders' %		Range	Range of Dev.

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			ME	NE		
UGs	10.7 ± 3.3	**ME**	72.2	27.8	3-16/13	-5.3-7.7/13
Interns	14.4± 2.5	**ME**	93.8	6.2	8-17/9	-2.6 – 6.4/9
PGs	13.3 ± 2.5	**ME**	99.1	0.9	7-16/9	-2.6 – 6.4/9
P PGs	13.4 ± 3.1	**ME**	90	10	8-17/9	-2.6 – 6.4/9
NCFs	13.5 ± 2	**ME**	100	0	9-17/8	-3.5 - 4.5/8
CFs	14.5 ± 1.9	**ME**	98.4	1.6	8-17/9	-6.5-2.5/9

Table 3: Shows Statistical weighted mean analysis of class wise population

Column 1	2	3	4
Weight wise classes and Total populations	M	% of G P	D N TTA
UGs (Class 1)	10.7	100	ME for M
Ints+PGs+NCFs (Class 2)	13.5	100	ME for M
P PGs+ CFs (Class 3)	14.3	100	ME for M
Total population	Weighted Mean		
UGs+Interns+PGs+ P PGs+NCFs+CFs	13.23	100	ME for WM

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