

# The Impact of Simulation-Based Teaching Module Involving Virtual Dissection on Anatomy Curriculum Delivery

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## ABSTRACT

**Background:** Knowledge of anatomy, one of the core preclinical subjects, is very important for medical undergraduates to have a thorough understanding of various clinical conditions. The traditional method of learning anatomy involves dissection of human cadavers. Medical education system is entering an era in which the traditional teaching methods are being supplemented by newer technological teaching techniques. Simulation based teaching like virtual dissection table "Anatomage" can enhance the understanding and retaining capacity of the subject. The aim of the study is to determine the perception of virtual dissection, among students and staff and to compare the knowledge acquired through simulation based teaching and traditional teaching method.

**Material and Method:** The study comprised of 150 first-year MBBS students who attended regular theory class on 'joints of musculoskeletal system' and answered pre-test. The students were divided into two groups, based on teaching method, one which involved the use of a virtual dissection table, and the other, involving the use of cadaveric dissection. The students were made to attempt the post-test. The students were then assessed based on their responses to the pre- and post-tests. Feedback on the overall utility of the table from both students and staff was taken.

**Results:** The mean post-test scores were significantly higher than the mean pre-test scores, irrespective of the teaching method used. ( $p < 0.001$ ) However, the students who were exposed to the virtual dissection table scored comparatively better in the post-test than those exposed to cadaveric dissection. ( $p < 0.001$ ) 100% of the faculty and 93.3% of the students agreed that three-dimensional visualization improves understanding of anatomical structures.

**Conclusion:** The findings of this study suggest that though cadaveric dissection and virtual dissection enhance learning, the students tend to perform better with virtual dissection. The incorporation of simulation-based teaching into the Anatomy curriculum is essential to supplement traditional cadaveric dissection and ensure engaging as well as high impact delivery of the curriculum.

**KEY WORDS:** Simulation, Virtual dissection, Musculoskeletal, Anatomage, Cadaver, Dissection, Anatomy, MBBS, Teaching Methodologies.

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## INTRODUCTION

Anatomy is one of the core pre-clinical subjects in medical education. Students become familiar with the subject right from the first year of medical school and gradually build on the knowledge obtained as they move on to learn clinical subjects, during the next few years of medical school life. Adequate knowledge of anatomy is very much essential for a thorough comprehension of various clinical diseases.

The traditional method of teaching gross anatomy involves the use of cadaveric dissection under the guidance of faculty or demonstrators. Cadaveric dissection allows medical students to visualize anatomic structures, helping them to recall anatomic structures following theoretical lectures [1]. Moreover, cadaveric dissection also aids in training for surgical specialties [2]. However, there are certain limitations linked with cadaveric dissection such as difference in color and texture of anatomical structures from living individuals, high cost, shortage in supply and the limited duration over which the cadavers can be used [3,4].

The medical education system is entering an era in which traditional teaching methods are being supplemented by new technological teaching techniques such as three-dimensional (3D) visualization and simulation technologies, augmented reality, 3D printed anatomic models and radiological methods. These technologies ensure an engaging learning experience and help students retain information better [1]. The current Indian medical education focuses on active and student-centered learning [5], which cannot be fulfilled with didactic lectures and learning based on textbooks alone. The need for integration of multi-modal teaching strategies is essential to bring about a change.

Simulation-based, virtual dissection table (VDT) called 'Anatomage' (Anatomage Inc., San Jose, Ca, USA), has proven to enhance the understanding and retaining capacity of students. It allows for exploration and learning of human anatomy beyond what can be offered by cadaveric dissection.

Anatomage is a collection of stereoscopic images of various parts of the human body that is reconstructed to assume a three-dimensional (3D) representation of a human being. One can easily dissect the virtual cadaver and understand the relationship between various body parts and internal structures. The virtual table also allows users to learn anatomy through medical imaging. Once the virtual dissection is complete, the user can reset the virtual cadaver, to be used for another session [6].

Several studies have shown that utility of a VDT has a positive learning outcome when compared to traditional teaching methods [6-9].

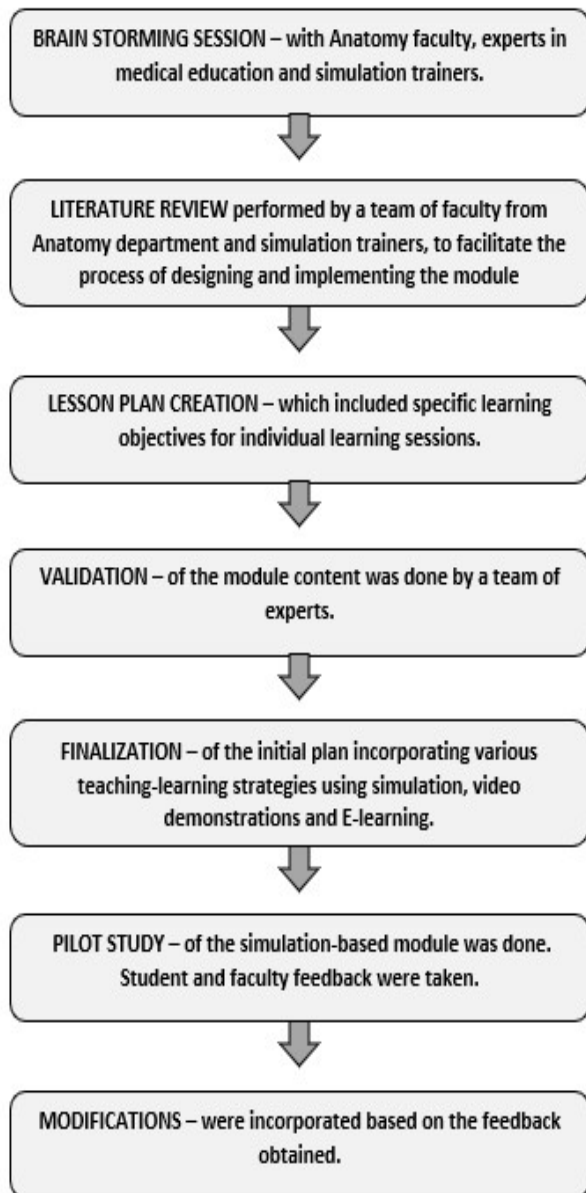
The availability of literature evaluating the impact or learning outcome of simulation-based teaching (SBT), especially in context with the prevailing medical education system in India, is limited. Hence, this study was carried out to compare the knowledge acquired through SBT using virtual dissection and traditional teaching approaches. The study also aimed to assess the perception of both students and staff regarding the SBT modality used.

## MATERIALS AND METHODS

The cross-sectional study was conducted at Yenepoya Medical College (Yenepoya deemed to be University), Mangalore, Karnataka in 2017. Institutional Ethics Committee clearance was taken before the commencement of the study. (IEC No. YUEC404/2017)

A needs assessment survey was carried out to investigate topics in Anatomy which are difficult for medical undergraduate students to understand and reproduce. The responses to the survey were collected from first-year MBBS students who passed out recently. The needs assessment revealed that students found learning 'joints in musculoskeletal system' very difficult. Hence, a teaching-learning module using virtual dissection table Anatomage based on the topic was developed for 150 first-year MBBS students

**Module development:** The simulation-based module was conceived, designed and tested as shown in Figure 1.



**Fig. 1:** Overview of conceptualization and implementation of simulation-based module.

**Module implementation and assessment:**

Regular theory class was taken for the first-year MBBS students on ‘shoulder joint’ by an assigned teacher. Pre-test was conducted for all the students. The following day, students were divided into two groups, wherein, the same topic was taught to one group (A) on cadaver in the dissection hall and to the second group (B) using Anatomage. This session was followed by a post-test. Each group comprised of 75 students.

The same pattern was repeated for the same set of 150 students for another topic, i.e., ‘hip joint’. However, the teaching methods were reversed for groups A & B.

The students were assessed based on their

responses to the pre- and post-session questionnaire of both topics. Feedback on the overall utility of the VDT from both students and staff was taken using an online form tool.

**Statistical analysis:**

was done using SPSS version 18. Categorical variables were represented as frequency and percentage and continuous variables were represented as mean ± SD. Comparison of pre- and post- session mean scores within the same group was done using paired t test while comparison of mean scores between two different teaching groups was done using Student t test. Statistical significance was achieved at p<0.05.

**RESULTS**

The results of the pre- and post- tests for shoulder joint and hip joint modules are shown in Tables 1 & 2 respectively.

**Table 1:** Mean scores for shoulder joint module.

Groups	Pre-test score	Post-test score
Group A (Anatontage)	4.16 ± 1.58 (1-8)	8.72 ± 1.45 <sup>a**,b**</sup> (3-10)
Group B (Dissection hall)	4.05 ± 1.72 (1-9)	6.68 ± 1.93 <sup>b**</sup> (2-10)

Data represented as mean ± SD (minimum-maximum) a, comparison of mean scores between Group A and Group B b, comparison of pre- and post- test mean scores in the same study group \*\*, p<0.001

**Table 2:** Mean scores for hip joint module.

Groups	Pre-test score	Post-test score
Group A (Dissection hall)	4.64 ± 1.66 (1-8)	6.64 ± 2.02 <sup>a**,b**</sup> (2-9)
Group B (Anatontage)	4.36 ± 1.77 (0-8)	8.01 ± 1.53 <sup>b**</sup> (3-10)

Data represented as mean ± SD (minimum-maximum) a, comparison of mean scores between Group A and Group B b, comparison of pre- and post- test mean scores in the same study group \*\*, p<0.001

The perceptions of the students and teachers on the utility of the VDT are shown in Figures 2 and 3.

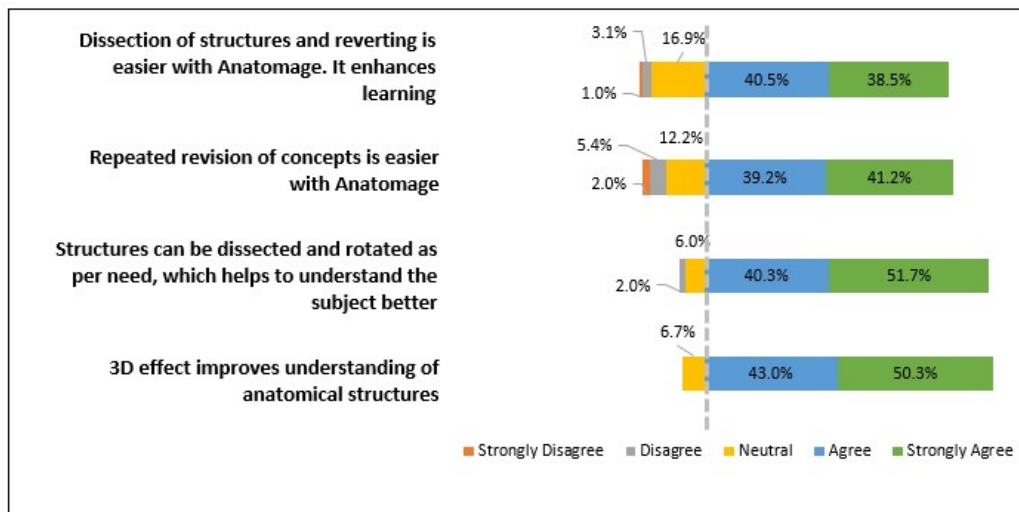


Fig. 2: Perception of students on the utility of virtual dissection table (n=150).

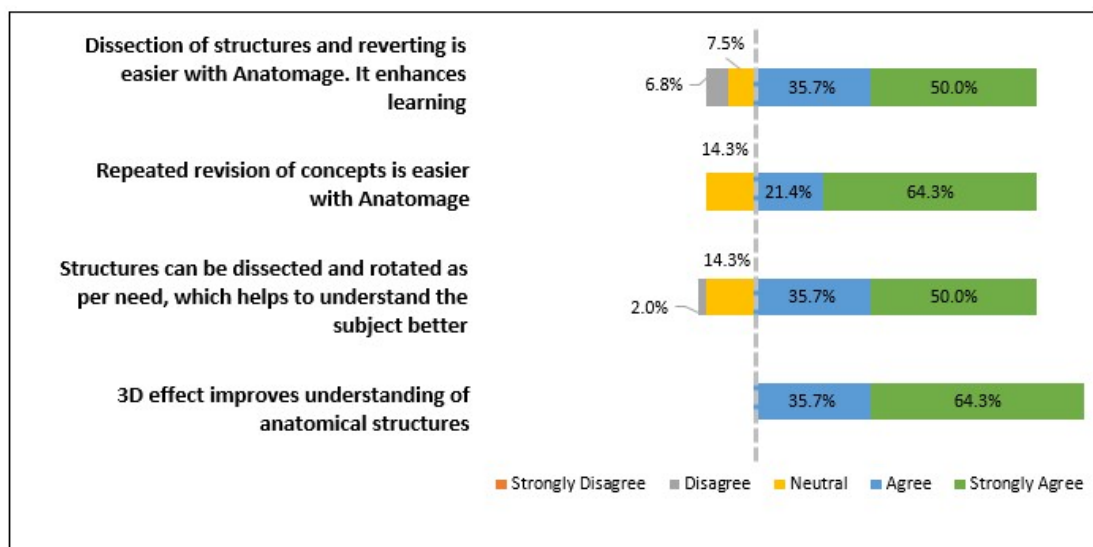


Fig. 3: Perception of faculty on the utility of virtual dissection table (n=14).

## DISCUSSION

The teaching methods in Anatomy have evolved over the years. Traditional teaching methods involving didactic lectures and cadaveric dissection are being supplemented with innovative teaching methods. Model making, being cost-effective, is popular among educators to make learning anatomy interesting [10,11]. With the advancement in technology, educators are being exposed to a wide range of alternative methods that prove to be far more engaging.

Traditional cadaveric dissection is being supplemented or replaced by VDTs in certain medical schools. VDTs provide a simulated environment, providing 3D visualization of anatomical structures in a virtual cadaver. In virtual dissection, students can perform the same dissection method repeatedly in the

same virtual cadaver, unlike conventional cadavers which cannot be reused to perform the same type of dissection. In few medical schools, where the procurement of cadavers has become difficult, the use of a VDT is of great help to complete the curriculum [12]. The stressful and unpleasant experience that medical students face when they enter the dissection hall for the first time is another aspect of cadaveric dissection. A study carried out by Chia T.I and colleagues to evaluate the experience of medical students in anatomy dissection halls revealed that 21% of the students (n=18) were shocked and 16% (n=14) were reportedly frightened on their first day in the dissection hall. 34% (n=30) of the students even developed palpitations. The main reasons for such an unpleasant experience were attributed to the smell emanating from the dissection hall and the

sight of a cadaver [13]. This can be overcome by introducing the students to virtual dissection first and gradually exposing them to the cadaver.

The current study focused on creating SBT modules for topics deemed difficult by the students, in Anatomy, such as joints. The study also aimed to determine the perception of VDT among students and faculty. The module developed for the musculoskeletal system was liked by faculty and students. The majority of the staff and students believed that 3D visualization enhances the understanding of anatomical structures. The mean post-test scores were significantly higher than the mean pre-test scores, irrespective of the interventional method used and topic taught. ( $p < 0.001$ ) However, the students who were exposed to the VDT scored comparatively better in the post-test, of both topics, than those exposed to cadaveric dissection. ( $p < 0.001$ ) These findings suggest that though cadaveric dissection and virtual dissection enhance learning, the students tend to perform better with virtual dissection.

The positive response toward the VDT in the present study is comparable with the outcomes of various studies comparing the utility of virtual dissection over cadaveric dissection.

In a randomized controlled trial carried out by Boscolo-Berto R. et al, thirty second-year medical students who participated in an elective anatomic dissection course were subjected to pre-test on topographical anatomy and then randomly allocated into two experimental learning groups namely virtual dissection (interventional) group and textbook (control) group. Each group comprised of 15 students. The Anatomage table was used by the interventional group participants to learn and perform a virtual dissection of a human cadaver. Following this step, the students were asked to perform gross dissection on a human forearm and then answer a post-test. The students who learned with the help of virtual dissection showed better test performance than those who learned from textbooks and are three times more likely to show a positive outcome at post-test. The

authors concluded that a combination of both virtual and traditional gross dissection improved learning outcomes [9].

Darras KE and colleagues evaluated the students' attitude towards the integration of both cadaveric and virtual dissection, into the anatomy course. 78.7% of the first-year medical students felt that virtual dissection enhanced their understanding of what was taught during cadaveric dissection and enabled them to relate to associated clinical relevance. Several students also implied that visualizing 3D anatomic images was a major advantage of virtual dissection [14].

In another study where cadaveric dissection was replaced with Anatomage due a high number of students and the limited availability of cadavers, virtual dissection showed promising outcomes, provided the curriculum was tailored to incorporate the method of teaching and adequate training was provided to optimize its usefulness for learning. (8) Bork et. al. also reported that VDT is a value-added tool enhancing dissection and cannot serve as a replacement for conventional dissection [7].

In another study, the majority of the students preferred Anatomage as an adjunct to cadaver dissection and reiterated that virtual dissection enhances active learning. 89% of the medical students who participated in the study agreed that Anatomage helped them understand and visualize the body and internal structures better [6].

On the contrary, Anand et. al. found no significant difference in the gain of knowledge between students taught with VDT and those taught with cadaveric dissection. They proposed that virtual dissection is as good as conventional dissection while teaching Neuroanatomy [15].

## CONCLUSION

With the advent of newer technologies in medical education, anatomy educators must keep themselves abreast with the latest modalities of teaching to ensure effective and high-impact delivery of the Anatomy curriculum.

The efficacy of VDT as a teaching tool and its

implementation in the existing medical curriculum in India has not been extensively explored, though there are related literatures available from other countries. This study is one of the few contributions from India that focusses on SBT in Anatomy based on usage of VDT.

In the current study, students performed better in their post-tests after being taught on the virtual table 'Anatmage' as compared to those taught in the dissection hall. Both staff and students opined that VDTs had many advantages. Such virtual tables may be used as a supplement and not a substitute, as they cannot give the real feel of structures.

Students and faculty also accepted the fact that simulation fosters effective learning through active learner engagement and repetitive practice.

We recommend the incorporation of cadaveric as well as virtual dissection into the curriculum. SBT may be a boon for medical students, especially in countries where scarcity of cadavers prevails. We also suggest that topics in Anatomy which are considered difficult to comprehend especially by first-year medical undergraduates can be made more engaging by developing more simulation-based modules in the future.

## ABBREVIATIONS

**3D** - Three-dimensional

**SBT** - Simulation-based teaching

**VDT** - Virtual dissection table

**Conflicts of Interests:** The authors declare that they have no competing interests.

## Author Contributions

**Qudusia Sultana** : Conceptualizing and designing the study protocol

**Rashmi Jain** : Data Collection

**Amith Ramos** : Literature review, drafting the manuscript

**M.H. Shariff** : Designing the data collection tool, editing the manuscript

**Pranup Roshan Quadras**: Statistical analysis and interpretation of data

All authors reviewed the results and approved the final version of the manuscript.

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