Original Article

Comparative Effectiveness of Traditional Lecture, Flipped Classroom, 3D Visualisation, and Case-Based Learning in Undergraduate Anatomy Education

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Abstract

Background: Knowledge of anatomy is essential in medical education but conventional teaching approaches do not effectively promote spatial perception or clinical thinking. This has resulted in the combination of active learning and technology-enhancement learning approaches. This study is designed to assess the effectiveness of the traditional lecture, flipping the classroom, 3D visualization and clinical case-based learning in improving the anatomical knowledge, spatial understanding, clinical reasoning and interest of the students. **Material and Methods:** An educational study performed by taking 100 first year MBBS students and randomly categorized into four groups of 25 students each for teaching purpose. Before and after anatomical knowledge, spatial comprehension and clinical reasoning was assessed using structured tests. A valid Likert scale questionnaire was used to assess student engagement. ANOVA and Tukey post-hoc tests were used to analyse data. **Results:** All teaching method increased the post-test scores significantly compared to initial evaluation. The use of 3D visualization led to the highest levels of knowledge and spatial understanding. The highest marks in clinical reasoning and engagement levels were earned by the clinical case based learning group, in contrast. Besides this, the group that used the flipped classroom showed significant improvement in comparison with the traditional lecture group. **Conclusion:** The use of active and technology-based teaching methods is able to improve the learning outcomes of anatomy more than conventional lectures. The addition of various 3D visualizations, case-based learning and flipped classroom techniques to the anatomy curriculum can lead to enhanced knowledge retention, spatial perception and clinical application of the concepts.

Keywords: Flipped classroom, 3D visualization, Case-based learning, Active learning, Anatomy education, Medical students.

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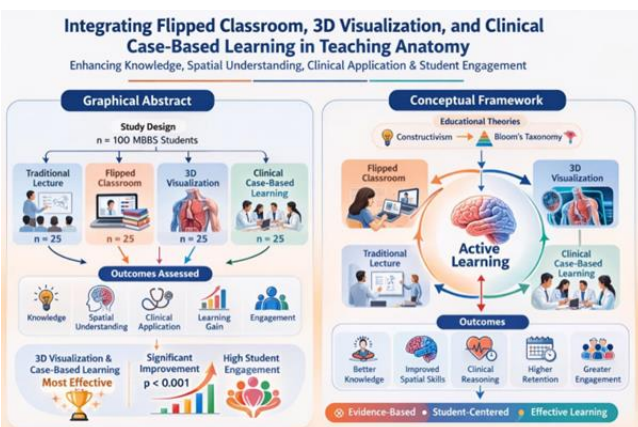

Introduction

In the global realm, anatomy training is a vital part of medical education, as the backbone of clinical expertise and the means to the safe practice of medicine. Traditional education has relied on the delivery of comprehensive information about structure and spatial awareness using lectures and dissection of cadavers, which are long-standing, traditional approaches considered the standard for teaching this rapidly growing area of the subject. There are many challenges with traditional methods of teaching anatomy, including decreased availability of cadaver dissection, high operating costs, ethical problems, and low student engagement rates. This has encouraged researchers to look into other and alternative forms of teaching that could be used as a supplement or alternative to traditional teaching.[1,2]

Technological advancements, particularly in three dimensional (3D) visualization and virtual reality (VR), have garnered much interest as a possible transformative tool in the teaching of anatomy. It is found that these technologies contribute to factual knowledge and spatial knowledge acquisition as well as to the satisfaction and engagement of learner.[3,4] Virtual reality, for instance, provides interactive, 3D, immersive experiences that can help learners interact with 3D models and give them a deeper conceptual understanding, and better skills of mental rotation

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necessary to comprehend complex spatial relationships.[4,5] Although virtual reality (VR) and augmented reality (AR) present many opportunities, there is an increasing consensus that these technologies should be integrated with, not taken the place of, cadaveric dissection, which is considered essential for hands-on tactile learning and building professional identity.[6,7]

Besides technological advances, pedagogical tools such as the flipped classroom model and the clinical case method enhance learning by having the students engage in time management activities before or outside of class, and using anatomical knowledge in the context of real clinical cases. All these strategies will improve higher level thinking, critical thinking and the application of theory to practice skills that are vital to medical education in today's world.[8] Furthermore, anatomical models and plastinates have been shown to be a cost effective and easily available resource that aids the comprehension of three dimensions and hands-on learning which is particularly problematic in learnings environments with limited resources.[4,9]

Online and remote learning have been accelerated by the COVID-19 pandemic, and an evaluation of the effectiveness of online and remote learning methods to in-person learning is needed. Academic results appear to be comparable for online learning and face-to-face learning, although students tend to be more satisfied with traditional learning. This underscores the continued need for blended and multimodal curricula that are flexible and provide for more hands-on learning experiences.[10] However, economic evaluations highlight the role of cost-effectiveness in curriculum development, and computer-assisted learning and technologic instruments have been shown to provide a higher education value per dollar than those with greater resources such as dissection.[11]

Much research has been carried out, but there is no method that has been proven to be a definite winner. This indicates the need to adopt a multi modal integrated approach that has a mix of traditional and innovative tools suited to the institutions' resources and the needs of learners.[8] This integration not only simplifies the acquisition of knowledge and skill building, but it also addresses the different types of learners it supports, increases motivation, and prepares students for clinical practice.

Experiments are conducted in this study to assess the effectiveness of different teaching methods in enhancing the knowledge of gross anatomy, spatial awareness, clinical reasoning, and engagement of first-year medical students, such as traditional lectures, flipped classrooms, 3D visualization and clinical case-based education. The study aims to provide detailed comparative data to inform evidence-based curriculum development and promote the use of sensitive anatomy teaching methods that are both effective and utilize resources wisely, to support current medical education requirements.

Materials and Methods

Study Design and Setting: This prospective interventional educational study was conducted in the Anatomy Department at Mahabodhi medical college and hospital, Gaya, India. The research aimed to evaluate and compare the effects of different innovative teaching strategies on improving anatomy learning outcomes for undergraduate medical students. The study spanned six weeks and was carried out during the regular academic term for First-year MBBS students. Before commencing the study, institutional ethical approval was obtained, and all participants provided their informed consent to participate [Figure 1].

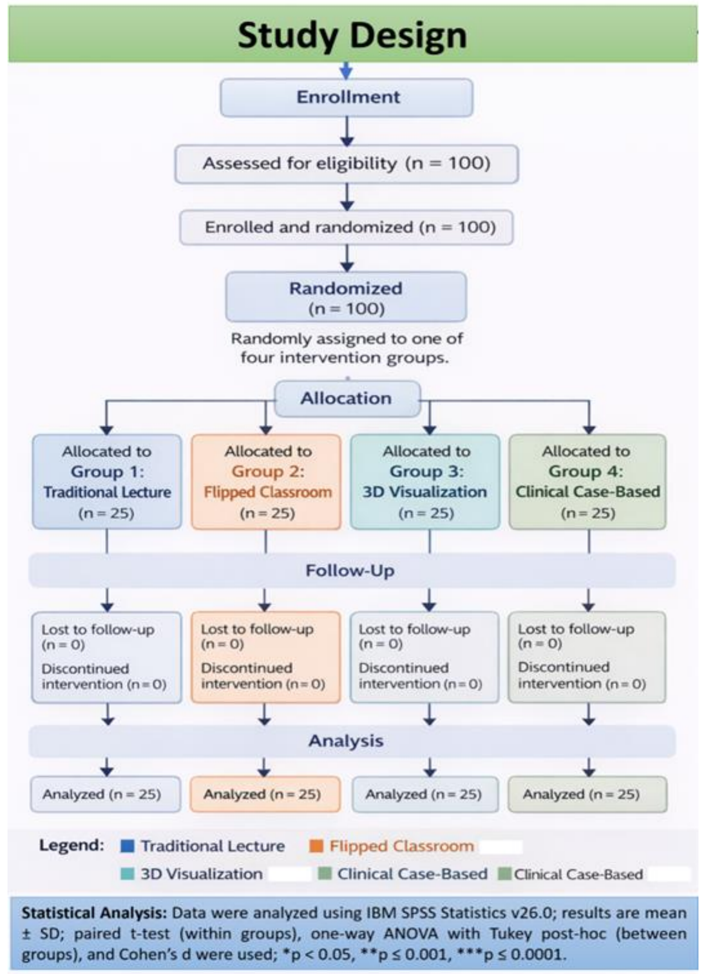

Figure 1: Study Design

Participants: A study was conducted with 100 First-year MBBS students. These participants were selected from those attending regular anatomy classes. To be included, students had to be officially registered in the First-year MBBS program and agree to take part in the study. Students who missed either the pre-intervention or post-intervention evaluations were not considered in the analysis. The final group comprised 82 male and 18 female students. All participants who met the criteria completed the study and were included in the final analysis.

Randomization and Group Allocation: Participants were randomly allocated into four equal groups using a computer-generated randomization procedure. Each group consisted of 25 students. Group 1 served as the control group and received traditional lecture-based teaching. Group 2 received instruction through the flipped classroom model. Group 3 was exposed to anatomy teaching using three-dimensional visualization techniques. Group 4 received instruction using clinical case-based learning strategies. Randomization ensured equal distribution of students across groups and minimized selection bias.

Teaching Interventions: All groups were given the same topic of anatomy to teach, to achieve the same outcome of learning. The chosen module was focused on the upper limb anatomy, brachial plexus and its clinical significance. The students in the traditional lecture group were taught through the traditional lectures, PowerPoint presentations, and chalk and board demonstrations by faculty. The pre-recorded video lessons and readings were provided to the students in the flipped classroom group, which then concentrated on discussion, clarifying concepts, and conducting interactive problem-solving during class. The 3D visualization group used digital 3D anatomical models and visualization software, which gave students the opportunity to interact with the anatomical structures, enhancing their spatial understanding. The clinical case-based learning group incorporated clinical scenarios that were associated with the anatomical concepts and learning was supported through guided group discussions in which the anatomy concepts were applied to clinical scenarios. There were three sessions (about 60 minutes each) for each instructional method.

The Assessment of Learning Outcomes are assessed.

Learning outcomes were assessed using a structured framework, which involved measuring knowledge, spatial understanding, clinical reasoning, and student engagement. The validated multiple choice questionnaire consists of 20 items concerned with the anatomy topic discussed during the intervention was used for measuring knowledge acquisition. This assessment was given in two phases – before the intervention (pre-test) and after the teaching was completed (post-test). One point was awarded for each correct answer and a maximum of 20 points could be achieved. Spatial understanding of anatomical relationships was evaluated using spatial identification test in which the students were tested by the use of diagrams with the anatomical parts labeled and a series of orientation based questions probing the students' ability to identify anatomical relationships and parts. The clinical reasoning ability of students was evaluated with a group of multiple choice questions based on clinical scenarios and problems which were to be solved with the help of the knowledge of their anatomy. The measure for student engagement was a structured questionnaire that included 15 statements addressing student interest in learning, class participation, clarity of teaching methods and perceived effectiveness of the learning strategy. The responses were taken using a five point likert scale from disagree strongly to agree strongly. The reliability of the questionnaire was determined by Cronbach's alpha values to check its internal consistency.

Statistical Analysis: Data obtained from the study were inputted to Microsoft Excel and analysed using IBM SPSS Statistics version 26.0. The continuous variables were shown as the mean and standard deviation. Paired sample t-tests were used to determine the effect of the teaching intervention for each group using pre and post test scores. One way ANOVA was used to assess the variations amongst four teaching groups. For analysis when significant differences were found in the ANOVA results, Tukey's HSD test was used as a post-hoc analysis test to find specific differences between groups. The effect sizes were calculated by taking Cohen's d for each method of teaching education and comparing it to the traditional method. The significance level was determined by p value <0.05.

Ethical Considerations: The study protocol was submitted for review by the Mahabodhi medical college and hospital, Gaya Institutional ethics committee and it was approved. All students were informed consent participants and informed consent forms were signed prior to their entry into the study. The information of the participants was kept confidential throughout the study and the data analysed in an anonymous way.

Results

Participant Characteristics: A total of 100 students of MBBS first year who were under gross Anatomy course were involved in the study. The participants were randomly assigned to four groups with the Traditional Lecture (control) group, Flipped Classroom group, 3D Visualization-based learning group and Clinical Case-Based Learning group each having 25 participants. A total of 82 (82%) males and 18 (18%) females participated. There was no selection bias as the male and female participants in the four groups were all evenly distributed. A Chi-square test of independence was performed to see whether there were significant differences in the gender distribution for the groups. The results showed that there was no difference between groups for male/female ratio ($\chi^2 = 0.38$ p = 0.91). This means that the two groups were at the start comparable in their demographics, minimising the chance of outcome being due to gender difference. That the two groups were randomly allocated and were comparable in all other relevant demographical aspects was important; if any differences emerged in the post intervention period they were most likely due to the differing teaching methods used. In each group, the proportions of the male students were within 16 to 20:16 to 20 and in each case the ratio of the males was between 80% to 84% in each group with the females ranging between 16% to 20%. These results validate subsequent comparisons of the four study groups in terms of academic performance, spatial understanding, clinical reasoning ability and outcomes of student engagement.

Baseline Knowledge Assessment (Pre-Test Scores): Before the teaching interventions were introduced, participants underwent a baseline knowledge test (pre-test) comprising 20 multiple-choice questions on gross anatomy and basic neuroanatomy concepts. This assessment aimed to evaluate whether the four groups were academically similar prior to the educational interventions. The average pre-test scores (± SD) were comparable across all groups: Traditional Lecture (9.7 ± 2.1), Flipped Classroom (10.0 ± 2.0), 3D Visualization (9.9 ± 2.2), and Clinical Case-Based Learning (10.1 ± 2.1) out of a possible 20 points. A one way analysis of variance (ANOVA) was used to determine whether there were significant ($p<0.05$) differences in baseline knowledge among the groups. The results indicated that there was no difference in the pre-test scores [$F(3,96) = 0.18$, $p = 0.91$] suggesting that there was no difference in the students' pre-test knowledge prior to the intervention. There was little difference between and in groups and this further confirmed the effectiveness of the randomization process. There is a very small effect size for differences in the baseline ($\eta^2 = 0.006$); that is, less than 1% of the variance in baseline scores is attributable to group allocation. The results show that all four study groups had the same academic status prior to teaching the different teaching strategies and that any subsequent improvements in performance were due to the different teaching strategies used. The pre-test scores as shown in [Figure 1], there was no significant difference between groups at baseline [Figure 2A].

Comparison of Post-Test Knowledge Scores Among Teaching Methods

Post-test results showed significant differences between instructional methods for knowledge scores. There was no statistically significant difference between the scores of the groups. The highest mean score (18.1 ± 1.9) was obtained by the group using 3D visualization method, followed by the clinical case-based learning group (17.4 ± 2.0) and the flipped classroom group (16.2 ± 2.1). The lowest scores (13.5 ± 2.3) were obtained in traditional lecture group. The one-way ANOVA revealed a statistically significant difference between the groups in the post test scores ($F(3, 96) = 18.74$, $p < 0.001$; $\eta^2 = 0.37$). All three active learning techniques led to significantly better scores than traditional lecture learning, after further analyses with Tukey's post-hoc test. The mean difference in the 3D visualization group was 4.6 points, which was the largest compared to the lecture group ($p < 0.001$). The clinical case-based learning method also performed significantly better than lectures ($p < 0.001$), and the performance of the flipped classroom method was also in the moderate range, but there was a significant improvement ($p = 0.004$). The scores for active learning methods 3D visualization were significantly better than the scores for the flipped classroom method ($p = 0.031$). The difference between 3D Visualization and Clinical case Based Learning, and, the difference between Clinical case Based Learning and Flipped classroom, were not statistically significant. Both these results showed that the anatomical knowledge was significantly improved using teaching strategies with technology and case-based methods than with traditional methods using lectures [Figure 2B].

Within-Group Improvement in Knowledge Scores: Paired t-tests were conducted in each group to measure the effectiveness of each teaching method by comparing the pre and post test scores within the group. There were statistically significant improvements of all four groups compared to their pretest scores ($p < 0.001$). Small but significant improvements (+3.8 points; $t = 9.82$; $p < 0.001$) were observed in the scores of the group that had previously been lectured, from 9.7 ± 2.1 to 13.5 ± 2.3. The students in the flipped approach group were found to gain more with from 10.0 ± 2.0 to 16.2 ± 2.1, which is a mean of 6.2 points ($t = 15.50$, $p < 0.001$). The 3D visualization group made the greatest improvement in terms of mean scores (9.9 ± 2.2 to 18.1 ± 1.9, $t = 19.53$, $p < 0.001$). Similarly, the clinical case based learning group improved significantly, increasing their score from 10.1 ± 2.1 to 17.4 ± 2.0 for a mean gain of 7.3 points ($t = 18.25$, $p < 0.001$). The 3D visualization, clinical case-based learning, flipped classroom approaches had the highest learning gain, with the traditional lecture group having the lowest gain. These findings show that use of active learning strategies is more effective than the passive learning style (lecture) to gain knowledge about anatomy and physiology in learning [Figure 2C].

Spatial Understanding Assessment: Students were tested for their understanding of the three dimensional anatomy after the teaching interventions to include a level of skill within the comprehension of identifying structure and orientation by using a spatial understanding test. The clinical case based learning group (15.8 ± 2.0) and the flipped classroom group (14.5 ± 2.2) did not significantly differ.The clinical case based learning group (15.8 ± 2.0) did not significantly differ from the flipped classroom group (14.5 ± 2.2). The lowest performance (11.1 ± 2.4) was observed in the traditional lecture group. The differences in the spatial understanding scores between the four groups was statistically significant ($F(3,96) = 24.36$, $p < 0.001$). This effect size was quite large ($\eta^2 = 0.43$), indicating that spatial thinking instruction accounted for a large amount of the variance in spatial knowledge. A follow-up post hoc test indicated that all three active learning strategies yielded higher levels of spatial understanding than traditional didactic learning (lecture-based). The 3D visualization group demonstrated the greatest gains ($p < 0.001$) with a mean difference of 6.5 points when compared to the lecture group. The finding indicates the usefulness of the interactive three-dimensional models in improving spatial cognition in the field of anatomy instruction. In addition, the mean of 3D visualization was significantly higher than the mean of flipped classroom ($p = 0.005$); but 3D visualization was not significantly different compared to the mean of clinical case based learning ($p = 0.102$) and the mean of flipped classroom was not significantly different compared to the mean of clinical case based learning ($p = 0.123$).These findings indicate that 3D visualization tools significantly improve spatial understanding of anatomical structures, a crucial aspect of anatomy education [Figure 2D].

Clinical Application and Reasoning Scores: The ability to reason clinically was evaluated through case-based multiple-choice questions aimed at assessing the use of anatomical knowledge in clinical situations. The group engaged in clinical case-based learning achieved the highest average score for clinical application (17.8 ± 1.1), followed by the group using 3D visualization (16.1 ± 1.2) and the flipped classroom group (15.3 ± 1.3). The traditional lecture group had the lowest score (12.6 ± 1.4). A one-way ANOVA indicated a statistically significant difference among the four groups ($F(3,96) = 38.72$, $p < 0.001$). The effect size was large ($\eta^2 = 0.55$), suggesting that the teaching method significantly influenced students' clinical reasoning performance. Tukey post-hoc analysis showed that all three innovative teaching strategies led to significantly higher clinical application scores compared to the traditional lecture group. The clinical case-based learning group demonstrated the most improvement, with a mean difference of 5.2 points compared to the lecture group ($p < 0.001$). Furthermore, the clinical case-based learning group scored significantly higher than both the flipped classroom group ($p = 0.01$) and the 3D visualization group ($p = 0.03$). However, the difference between the flipped classroom and 3D visualization groups was not statistically significant (p = 0.29). These results suggest that clinical case-based teaching methods are particularly effective in enhancing students' ability to apply anatomical knowledge in clinical settings, while 3D visualization improves conceptual understanding that also aids clinical reasoning [Figure 2E].

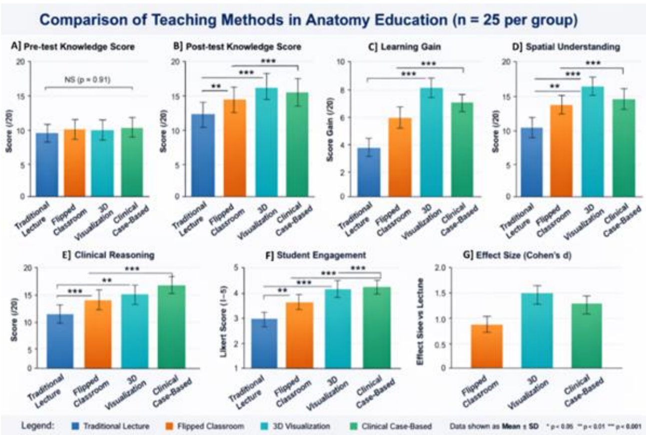

Figure 2. A comparative study of anatomy teaching techniques was conducted with 25 participants in each group. Panels (A–G) display the average ± SD scores achieved by students who experienced four different teaching methods: Traditional Lecture, Flipped Classroom, 3D Visualization, and Clinical Case-Based Learning. (A) Initial knowledge assessments showed no notable differences between groups (NS, p = 0.91), ensuring baseline equivalence. (B) Knowledge scores after the interventions significantly increased across all groups, with the 3D Visualization and Clinical Case-Based groups achieving the highest scores. (C) Analysis of learning gains indicated that the 3D Visualization group showed the most substantial improvement, followed by Clinical Case-Based learning, compared to traditional lectures. (D) Scores for spatial understanding were highest in the 3D Visualization group, reflecting improved comprehension of three-dimensional anatomy. (E) Clinical reasoning scores were notably higher in the Clinical Case-Based group compared to other methods. (F) Student engagement, measured on a 5-point Likert scale, was significantly greater in the 3D Visualization and Clinical Case-Based groups than in the lecture group. (G) Effect size analysis (Cohen's d) relative to the lecture group showed the greatest educational impact for the 3D Visualization method, followed by Clinical Case-Based learning and the Flipped Classroom approach. Error bars indicate standard deviation. Statistical significance is marked as *p < 0.05, **p ≤ 0.001, ***p ≤ 0.0001.

Student Engagement and Perception: A 15 item questionnaire with a Likert scale was used to gauge student engagement and opinions about teaching methods, ranging from 1 (strongly disagree) to 5 (strongly agree). The result of reliability analysed in this study was excellent reliability level with Cronbach's alpha coefficient of 0.88, indicating that the measurement of student engagement in this study is reliable. The group engaged in clinical case-based learning achieved the highest engagement score (4.6 ± 0.3), followed by the 3D visualization group (4.5 ± 0.4) and the flipped classroom group (4.1 ± 0.5). The traditional lecture group had the lowest engagement score (3.0 ± 0.6). A one-way ANOVA indicated a statistically significant difference in engagement levels across the four groups ($F(3,96) = 31.58$, $p < 0.001$). The effect size was substantial ($\eta^2 = 0.50$), suggesting that the teaching method had a significant impact on student engagement. Tukey post-hoc analysis revealed that all three active learning strategies led to significantly higher engagement scores compared to the traditional lecture method. Although clinical case-based learning and 3D visualization showed slightly higher engagement scores than the flipped classroom approach, these differences were not statistically significant. These results suggest that interactive and student-centered teaching methods significantly boost engagement and motivation in anatomy learning compared to conventional lecture-based instruction [Figure 2F].

Table 1: Effect Size (Cohen's d) Compared with Traditional Lecture

Teaching Method	Cohen's d	Interpretation
Flipped Classroom	0.92	Large Effect
3D Visualization	1.52	Very Large Effect
Clinical Case-Based Learning	1.31	Very Large Effect

Upon examining the effect size, it was found that 3D visualization had the greatest educational impact, with clinical case-based learning coming in a close second. Moreover, the flipped classroom method did better to overcome the traditional lecture method. These results emphasize the need for the use of technology supported visualization and clinically oriented learning styles in the learning of anatomy in the modern era [Figure 2G and Table 1].

Discussion

The findings of this research are added to existing works which emphasize the benefits of active teaching over traditional teaching approach in anatomy teaching. There were significant improvements with large effect sizes reported for groups in which 3D visualization was used and clinical case-based learning occurred, highlighting the educational value of immersive, interactive, and clinically contexted approaches. The present results are in line with those supported by meta-analytical data that the use of three-dimensional visualization technologies significantly improved factual and spatial knowledge of anatomy, as well as the satisfaction and motivation of the students.[4] One of the greatest merits of the use of 3D concept in understanding spatial area is consistent with studies showing that 3D visualization increases mental rotation skills, which are crucial for anatomy learning.[4] Case-based learning has led to great clinical reasoning gains that demonstrate the educational benefits of combining anatomical knowledge with clinical context, which support application of knowledge to diagnostic and therapeutic contexts. The method utilized is in line with the educational frameworks which has encouraged problem based learning with case studies to build better cognitive engagement and critical thinking skills in medical education.[8] Moreover, the very good results for student engagement scores in the clinical case-based and 3D visualization groups are consistent with the results found in previous studies on the motivational effects of student-centered, interactive learning methods that motivate students to actively participate in their learning process.[12]

The results indicate that the flipped classroom model has achieved great improvement than the traditional classroom model but is not as effective as 3D visualization and case-based learning. It indicates that the incorporation of more sophisticated visual aids or clinical situations may be needed to improve its utility in the learning of anatomy. This is consistent with the results of some mixed-method systematic reviews, which show that online/ hybrid instructional models are comparable in effectiveness to face-to-face models for most of the outcomes measured (but additional elements of in-person and hands-on instruction may be needed to optimize their effectiveness).[10-12] The literature does in fact suggest that any one approach is not the panacea but that a multimodal approach that combines lectures, dissection, virtual learning environments and problem based teaching can provide the multiple learning and teaching outcomes that are desired in teaching anatomy.[8]

Evidence that solid and virtual models are effective for retaining anatomical knowledge and understanding of concepts makes the other benefits of the 3D visualization technologies further supported from an educational viewpoint. While the high cost of computer equipment may pose difficulty for some schools, the value of physical models for improving spatial awareness and long-term memory retention has been demonstrated and they offer a viable provision or alternative to conventional teaching methods at a relatively low cost.[4] Further enhancements of these benefits have been provided by virtual technologies, including virtual reality (VR) and augmented reality (AR), providing immersive and interactive learning which has been shown to increase confidence and satisfaction in learning.[3,5] Utilization of these technologies is recognized as a current asset in the teaching of anatomy and are becoming a necessary component in modern anatomy education given the scarcity of cadaver resources and the need for scaling and consistency of training.[2]

Economic considerations are an important factor in the uptake of these innovative approaches. Although dissection is still considered the benchmark for thorough anatomical skill acquisition, it demands significant resources and is less practical in settings with limited resources. A cost-effectiveness analysis of the various teaching methods suggests that computer assisted learning and 3D visualization are very cost effective in terms of their educational value, and hence suitable for a use as much as possible.[11] Moreover, use of plastinates has been shown to be a valuable educational resource, and they can even be used in conjunction with other resources, since they can be used to reduce the costs and problems associated with the use of fresh cadavers.[13]

Students want to see the traditional elements in the course, such as cadaveric exposure, as well as some newer techniques and technology and interactive methods. The study highlights the importance of small-group teaching and provision of human specimens as well as e-learning tools, and supports the idea of a multimodal teaching strategy.[14] This aligns with advocating for the use of multimodal approaches when teaching surface anatomy, where the learning is contextualised and's hands-on and guided participation' happens in real clinical contexts.[12]

To wrap up, the study confirms that, when used in combination with traditional classroom delivery, an anatomy course with increased technology use, such as visualization, case-based clinical learning, and increase of student engagement is more effective in building knowledge, spatial orientation, clinical thinking, and engagement. The variety of educational approaches meets the holistic cognitive and practical competencies required for medical professionalism. Further research is needed to investigate the long-term memory of information, cost benefit analysis and improvements to virtual and physical anatomical models. In addition, the flexibility of modifying the mix of instructional methods in order to meet the needs and available resources within any particular institution, as well as the student's desire to leave a single institution while continuing to learn anatomy, will play an important role in the development of global anatomy education.

Conclusion

According to the findings of the present study, it is evident that the use of active teaching methods in the field of gross anatomy education is much more effective than the traditional lecture-based teaching method in using technology. The use of technique like three dimensional visualization and learning from clinical cases produce notable advantages in acquiring knowledge, spatial understanding, clinical reasoning and student involvement. Traditional lectures enhance some aspects, but they are not as effective in improving the high level cognitive and practical skills needed for today's health care practice. The use of interactive, student-centred and clinically relevant teaching strategies also enhances learning achievement and student motivation and satisfaction. The results support the provision of multimodal curricula on anatomy by integrating technology with contextual clinical education, depending on the resources available and educational goals set. This approach will optimize anatomical education to prepare students for the challenges of clinical practice and future learning.

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Conflicts of interest

There are no conflicts of interest.

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