

Effectiveness of Anatomy 3D Animation Models in Teaching General Anatomy Among Second-Year Dentistry Students

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ABSTRACT

This quantitative study examined the effectiveness of integrating three-dimensional (3D) animation models into General Anatomy instruction among second-year dentistry students at Centro Escolar University–Manila. Using a one-group pre-test–post-test design, the study involved 38 purposively selected students who participated in four instructional sessions focusing on the muscular system. Data were collected through pre-tests and post-tests to assess changes in students' academic performance following the integration of 3D animation models. Descriptive statistics, including mean and standard deviation, were employed to summarize the results, while the Wilcoxon Signed-Rank Test was used to determine the statistical significance of differences between pre-test and post-test scores.

Findings revealed an increase in the overall mean score from 33.68 (SD = 17.96) in the pre-test to 50.82 (SD = 9.85) in the post-test. The Wilcoxon Signed-Rank Test indicated a statistically significant improvement in students' academic performance ($Z = -4.693$, $p < .001$). Significant improvements were also observed across the anatomical regions assessed, including the back, abdomen, perineum, thorax, and limbs. These findings suggest that integrating 3D animation models into General Anatomy instruction may enhance students' understanding and academic performance by providing interactive visual representations of complex anatomical structures. The study concludes that 3D animation models represent a promising supplementary instructional tool for anatomy education. However, further research involving larger samples, control groups, and assessments of long-term knowledge retention is recommended to establish their broader effectiveness and educational impact.

Keywords: *Digital learning, 3D animation model, digital age, digital learning, academic performance*

INTRODUCTION

Teaching has been a revered noble calling that can be traced back from the ancient up to the modern times. It has been honored across cultures and history due to its role in guiding, inspiring, and empowering individuals. Teaching is defined “as an interactive process, primarily involving classroom talk which takes place between teacher and pupil and occurs during certain definable activities” (Edmund Amidon, 1967). Moreover, it is a process of imparting skills and information so that learning will occur. Smith in 1963 expounded that teaching is a system of actions involving an agent, an end in view and a situation including two sets of factors those over which the agent has no control (class size, characteristics of pupils, physical facilities, etc.) and those which he can modify (such as techniques and strategies of teaching).

These techniques and strategies serve as tools to successfully provide instruction to participants. It is made up of the ideas and methods of education. Class involvement, demonstration, recital, memory, case study, presentations, or a mix of these are common teaching approaches. The choice of teaching technique

or methods to be employed is mostly determined by the material or skill being taught, and it may also be impacted by the students' ability and passion (Vyas,2023).

Today, teachers can choose between traditional and digital methods of teaching. In traditional teaching method, teachers discuss the lessons using chalk or pen and a board or can be assisted with power point presentations and physical models which can offer structure and personal connection. Whereas, in digital method technology- mediated tools are used like gadgets and applications.

General Anatomy is one of the vitally important courses in Dental education as it gives the Dentistry students a detailed knowledge of this part of the human body. As future health care professionals, dental students should acquire accurate knowledge about the normal structures of the human body to develop correct diagnosis. Thus, formulating an appropriate treatment plan for optimum patient management and care.

Traditionally, this course was taught by laboratory teachers using cadavers or actual human remains that gave a three-dimensional learning experience. However, due to scarcity and difficulty in maintaining these specimens, it had gradually eliminated except for hard tissues like bones that require minimal maintenance. It has been replaced by plastic models. Despite of its accessibility, the quantity available in educational institutions are not enough for the students. Inadequate or lower-quality plastic models directly hinder students' academic performance by causing learning misconceptions, reducing cognitive engagement, and lowering lesson retention rates (Ugaldi et.al,2025).

Digital age transforms learning profoundly, with a few strokes and click of fingers learners can now dive into a large pool of knowledge. Great improvements in the internet made studying more accessible and portable eliminating the need to browse thick pages of books. Pieces of information are easily sorted out depending on the needs of the learners. Gadgets like smart phones, tablets, and laptops have now become inevitable tools for students in studying. Slowly replacing the traditional pen and paper. As innovations in gadgets continue so as the development of different soft wares that can make 3D animation models. These three-dimensional models are digital representations of an object, character or environment that can be posed, moved and rendered over time.

Animations play a significant role in education, particularly in the areas of visualization, motivation, and support for individualized learning pace. Accordingly, animation should be considered not merely as a technical resource but as a pedagogical method that can enhance learning (Szabo & Zitný,2026). This study aimed to know how effective 3D animation models in teaching General Anatomy on 2nd year Dentistry Students by measuring their academic performance.

Three Dimensional (3D) Animation Models and Learning in Digital Age

The digital age has transformed the way students learn by making education more interactive, accessible and technology-driven. One of the most effective innovations in modern education is the use of 3D animation models, which allows the learners to visualize complex concepts through realistic, three-dimensional representations. Although three-dimensional animations generated by computer have been present since 1960's it wasn't popularly used in the classroom not until year 2020 where the Covid-19 pandemic hit and it became the catalyst for the full implementation of technology enhanced learning. In addition, digital age learning produced student population who are "digital natives" a concept introduced by Prensky in 2001, characterized by their birth and adolescence in the era of technology and digital technology. Learners are accustomed to learning through multimedia and digital platforms. Integrating 3D animation models into instruction increases engagement, encourages active participation, and promotes self-directed learning (Aiyedun,2020). Unlike traditional textbooks and two-dimensional illustrations, 3D animation enables students to view anatomical structures from different angles, zoom in on specific parts and observe how body systems functions. Moreover, animation is more than just a visually appealing medium; it provides a multi-sensory learning experience that can help bridge the gap between abstract

concepts and concrete understanding. It serves as a universal language, allowing for the easy absorption of content, irrespective of cultural or linguistic barriers. (Sharma, et.al 2022).

Statement of the Problem

Since teaching and learning are now greatly influenced by technology, the researcher conducted a study to identify how effective 3D animation models in teaching General Anatomy on 2nd year Dentistry Students by measuring their academic performance. Specifically, the study sought to answer the following:

1. What is the pretest score of the students before utilization of 3D animation models in teaching General Anatomy laboratory class?
2. What is the posttest score of the students after utilization of 3D animation application in teaching General Anatomy laboratory class?
3. Is there a significant difference between the pretest and posttest scores before and after utilizing 3D animation models?
4. Will the use of 3D animation model will be helpful for the retention of lessons among students taking General Anatomy laboratory class?

METHODS

Research Design

The research study used a quantitative approach to examine the effect of utilizing 3D Anatomy animation model on subjects' academic performance.

Research Locale

The study was conducted in Centro Escolar University-School of Dentistry, Manila Campus. The subject of the study were 2nd year undergraduate Dentistry students of CEU-Manila taking General Anatomy subject.

Sampling Technique

Purposive sampling was used to make the inclusion of a predefined group, which referred as the subjects of the study. This involved the deliberate selection of participants based on characteristics, experiences, or knowledge relevant to the research question, prioritizing information-rich cases that provided depth of understanding rather than statistical generalizability.

In this study, the subjects met the following requirements:

1. 2nd year Dentistry Students of Centro Escolar University-Manila Campus
2. 2nd year Dentistry Students taking General Anatomy subject.
3. Students with gadgets like smart phones and/ or tablets.

In determining the sample size of the group, the researcher used the Slovin's Formula.

Procedure for Data Gathering

1. First session

There are 473 2nd year Dentistry students enrolled taking General Anatomy 1 subject this semester for the school year 2026-2027. Out of the total number, only 38 students were able to be the subjects of the study.

The research proper started at the first session with the agenda of orientation of the subjects. The orientation included the discussion of the objectives of the study and the advantages that the subjects will acquire. Researcher then instructed the subjects to use a specific 3D Anatomy animation model designed by © BioDigital, Inc. that was used throughout the duration of the study. Moreover, the researcher also oriented the subjects that pretest and posttest will be given at the beginning of the second and end of the fifth session and with 80 items each with 14 days interval as quantitative measures.

2. Second Session to Fifth Session

The researcher taught a specific topic about General Anatomy 1 which was about Muscular System. Due to the broad scope of this topic the researcher subdivided it into 4 parts that corresponded to each session of the study duration.

- a. **Part #1: Muscle of the Back and Abdomen:** Second Session
- b. **Part #2: Muscle of the Perineum and Thoracic Region:** Third Session
- c. **Part #3: Muscle of the Upper Limb:** Fourth Session
- d. **Part #4: Muscle of the Lower Limb:** Fifth Session

Sessions were conducted with 1–4-day interval each. Before beginning the second session, researcher gave pretest to measure subject's overall familiarity and knowledge of the topic. During each session, 3D animation model was used in teaching anatomical structure specifically different muscles of the body. At the end of the fifth session, the researcher gave a summative evaluation in the form of posttest to measure subjects' understanding of the topic. Also, it was used to assess the retention and mastery of the lessons taught using 3D animation model. Pretest and posttest scores from the beginning until the end of the session were compared and interpreted.

Conceptual Framework

Figure 1 shows an IV-DV Framework used in conducting this study. 3D Animation model was the independent variable that was used in teaching specific lessons in General Anatomy 1 to second year Dentistry students. Subjects' academic performance as the Dependent variable of the study was assessed prior and after the last session through evaluative tools like pretest and posttest to compare the efficacy of this method of teaching.

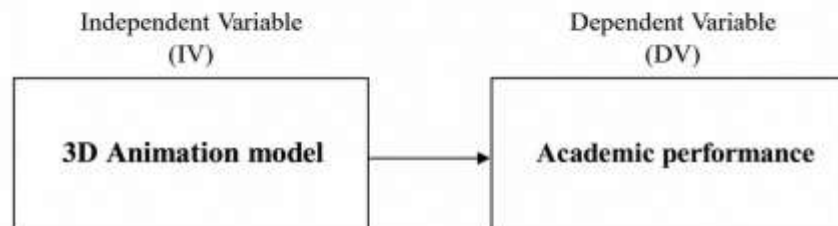


Figure 1. *Conceptual Framework*

Ethical Considerations

Before commencing the study, the researcher exercised ethical principles to protect the rights, privacy and welfare of the subjects.

Informed Consent- the researcher oriented the subjects about the objectives, scope, procedures and duration of the study. These pieces of information were disseminated properly so that the subjects' consent will be obtained prior to data gathering procedure.

Voluntary Participation- Participation in the study was entirely voluntary. Subjects had the choice to continue or withdraw from the study without penalty or consequence.

Confidentiality and Data Privacy- All the information of the subjects were treated with outmost confidentiality. Data collected were used solely for the purposes of the study and were only accessible to authorized individual.

Beneficence and non-maleficence- The study was conducted to contribute to the improvement of teaching and learning in General Anatomy course. The researcher took reasonable measures to minimize potential risks or inconvenience to participants and the use of 3D animation model was intended to support learning without causing academic disadvantage.

RESULTS AND DISCUSSION

The following data gathered from the respondents were analyzed using the mean, standard deviation and Wilcoxon Signed Rank Test to determine effectiveness of using 3D animation model in teaching General Anatomy in terms of students' academic performance.

Table 1. *Pretest Scores- Mean and Standard Deviation Result*

Topics	Mean	SD
Back and abdominal muscles	7.29	4.95
Perineum and thoracic muscles	9.63	5.47
Upper limb muscles	8.26	5.05
Lower limb muscles	8.50	5.59
Total pretest score	33.68	17.96

Table 2. *Posttest Scores-Mean and Standard Deviation Result*

Topics	Mean	SD
Back and abdominal muscles	15.61	5.65
Perineum and thoracic muscles	17.42	5.65
Upper limb muscles	14.95	4.40
Lower limb muscles	18.05	2.73
Total posttest score	50.82	9.85

The findings of the present study demonstrated a statistically significant difference between the pretest and posttest academic performance of second-year Dentistry students taking General Anatomy subject. As shown in Tables #1 and #2 among the four anatomical areas, the mean score for the back and abdominal muscles increased from 7.29 (SD = 4.95) in the pre-test to 15.61 (SD = 5.65) in the post-test. Similarly, the mean score for the perineum and thoracic muscles increased from 9.63 (SD = 5.47) to 17.42 (SD = 5.65), while the mean score for the upper limb muscles increased from 8.26 (SD = 5.05) to 14.95 (SD = 4.40). The lower limb muscles showed an increase from 8.50 (SD = 5.59) to 18.05 (SD = 2.73). Overall, the total mean score increased from 33.68 (SD = 17.96) in the pre-test to 50.82 (SD = 9.85) in the post-test.

Table 3. *Wilcoxon Signed Rank Test*

Variables (Pretest-Posttest)	Z value	Sig. value	Interpretation	Decision to Ho
Back and abdominal muscles	-5.07	0.000	Significant	Reject
Perineum and thoracic muscles	-5.17	0.000	Significant	Reject
Upper limb muscles	-5.17	0.000	Significant	Reject
Lower limb muscles	-5.24	0.000	Significant	Reject
Overall	-4.69	0.000	Significant	Reject

$\alpha = 0.05$ Level of Significance

The Wilcoxon Signed-Rank Test as shown by the result in Table #3 further revealed a statistically significant difference between the pretest and posttest total scores ($Z = -4.69$, $p < .001$). Significant differences were likewise observed across all four anatomical areas assessed, namely the back and abdominal muscles, perineum and thoracic muscles, upper limb muscles, and lower limb muscles. These findings indicated an improvement in students' anatomy test performance following the intervention.

General Anatomy is one of the most crucial courses in Dentistry curriculum that each dental student should master. Proper knowledge about human anatomical structures serves as a guide for clinicians to arrive at correct diagnosis, treatment planning, decision making and objective clinical judgment for every patient's welfare. Ideally, as what Ha and Choi (2019) suggested cadaver practice should be combined with theoretical education for proper understanding of anatomical knowledge. However, most universities use drawings on practice textbooks and plastic models to run training courses. To address this ongoing teaching problem the researcher conducted this study.

Results in table #1 answered the first problem stated in this study. As shown in the results back and abdominal muscles yielded the lowest mean score 7.29 (SD = 4.95) among the four topics discussed using 3D animation model because muscles in this region of the body are characterized by complex layered courses, fascial planes, specific vascularization, and innervation (Spiriev, et.al 2022) compared to muscles on the other regions of the body. Least score was followed by upper limb with mean score in pretest 8.26 (SD = 5.05), lower limb mean score of 8.26 (SD = 5.05) and perineum and thoracic muscles with mean score of 9.63 (SD = 5.47). Factors that influenced pretest results can be the following: First, is the concept of diversity in learning styles because subjects were heterogeneously grouped. Learning styles refers to the various approaches or preferences individuals have for absorbing, processing, and retaining information. Learning of the subjects can be through visual, aural, read/write or kinesthetic (Donald, G. et.al 2024).

Second factor is the study material or tool used by the subjects in learning the topics. According to Kılıç, G., et.al (2024) ^{despite} the growing use of digital tools in anatomy education, there remains a lack of structured, student-centered 3D modeling courses embedded within the undergraduate curriculum. Hence, students like the subjects of this study still rely on 2-dimensional images that can be viewed through textbooks and world wide web. Hence, students have difficulty in learning the anatomical structure because they have to learn the structure that is not actually visible by way of relying on the textbook pictures, and it is difficult to properly cultivate the ability to apply to the actual clinical practice under these circumstances (Ha, et.al 2019).

After utilizing 3D animation model, tables #2 and #3 gave answers to the third problem of the study. It showed the posttest scores and statistically significant difference on posttest scores on each topic compared to pretest scores. These improvements can be attributed to the immersive, interactive and exploratory natures of 3D animation models in learning and teaching. This nature +). These resources transcend traditional two-dimensional learning materials, offering students the opportunity to interact with and manipulate 3D models and ultimately contributing to a deeper comprehension of complex concepts of General Anatomy. Moreover, 3D models and animations in the teaching process significantly increased the students' intrinsic motivation for learning (Teplá, et.al, 2002).

The improvement in the mean and deviation results of pretest and posttest indicated that most of the undergraduates had shown interest in using animation in their classroom teaching and learning activities due to its effectiveness in facilitating learning. These findings coincided with results of the study done by Arumugam, et.al in 2022 they also found out animations to be an efficient way to deliver and disseminate information, thus making their respondents' education more stimulating besides enhancing their knowledge of computer skills.

Vyas (2023), which discussed students' insights regarding traditional learning, can likewise provide a basis for contextualizing the use of technology-supported instructional materials. In the present study, the use of Anatomy 3D Animation Models provided an additional visual and digital component to anatomy instruction. The significant difference between the pretest and posttest scores indicate that students' performance improved during the intervention period. This finding provides a basis for discussing how technology-supported materials may complement conventional approaches to anatomy education.

The findings of this study may also be considered in relation to Rashid, Khanum, and Rahim (2024), whose study examined animation as a teaching tool and its relationship to students' learning. In the present study, students demonstrated higher mean scores in the posttest across all four anatomical areas. Although

the educational levels and subject matter differ, the two studies provide converging evidence that animation can be a useful component of technology-supported instruction. The relevance of their work to the present study lies in the use of animation as an instructional medium. In the present study, the use of Anatomy 3D Animation Model was accompanied by an increase in students' posttest scores. Thus, the present findings are consistent with the broader premise that animation can be incorporated into instruction to support students' learning.

Moreover, Saufi (2025) provided a broader perspective on the transition from traditional classrooms toward digital learning and the challenges associated with contemporary e-learning. This perspective was relevant to the present study because the Anatomy 3D Animation Models represent a technology-supported instructional approach rather than instruction relying exclusively on conventional classroom methods. The improvement in students' post-test performance suggested that digital instructional resources can be incorporated into anatomy teaching. Nevertheless, the findings of the present study should be interpreted within the specific context of second-year Dentistry students and should not automatically be generalized to all forms of digital learning.

Taken together, the present findings and the cited literature provided a basis for discussing the potential value of animation and three-dimensional models in anatomy instruction. The statistically significant improvement in students' posttest scores, together with the literature concerning animation, 3D models, and digital learning, supports the relevance of technology-enhanced instructional materials in the teaching of General Anatomy. However, because the present study used a pretest and posttest design without a reported control group, the findings established a significant change in academic performance but should not be interpreted as definitive evidence that the Anatomy 3D Animation Models alone caused the improvement.

Moreover, results from Wilcoxon Signed Rank Test yielded significant ($p < 0.05$). It can be said that the intervention can hold promise as an effective pedagogy for teaching General Anatomy for dental students. The result of the present study aligned with the previous study by Szabó and Žitný in 2026 where they also highlighted the use of -M365 Copilot tool- an AI powered productivity tool as part of education process and concluded that students perceive animations as motivating and useful tools for learning.

CONCLUSION

The study conducted revealed that utilizing 3D animation model in teaching General Anatomy lessons is a promising innovative pedagogical tool to improve learning experience of students. As seen in the results, post test scores had a significant difference compared to pretest scores of the subjects despite of learning diversity. The improvement of academic performance of the subjects throughout the duration of the study further showed that by integrating this advancement in technology in a course which has been taught through didactic lectures truly facilitated interactive learning. In addition, innovative pedagogical tools like the use of 3D animation model should also keep up with the learning styles of the learners in digital age. Lastly, educators should also keep their minds open and adaptable to the rapid changes of the learners through time. Hence, educators like pedagogical tools should always be innovative and adaptive to the needs of the present time.

Limitation of the Study

Base on the findings and conclusion of this study, the researcher hereby identified the following limitations that should be considered for future studies.

First, the limited subjects of the study. There were only 38 second year Dentistry students voluntarily joined the intervention. Hence, the findings may not be generalizable to students from other year levels, academic programs, or institutions.

Second, the learning style diversity of the subjects. They learn in variety of ways such as through visual and kinesthetic styles. Since the researcher was not able to profile each subject according to their

learning style, the findings of this study should not also be generalizable to all types of learners but still can be a great teaching tool to enhance learning.

Third, the findings were limited by the duration of the intervention and the assessment methods used to measure students' academic performance. The results may reflect students' immediate learning outcomes rather than their long-term retention of anatomical knowledge. Other factors, such as students' prior knowledge, learning preferences, motivation, and familiarity with digital learning tools, may also influence their performance.

Finally, the study focused primarily on academic performance and does not comprehensively assess other potential benefits of 3D animation, such as students' engagement, motivation, spatial understanding, and learning experiences.

Despite these limitations, the study may provide valuable insights into the potential of 3D animation models as a supplementary instructional tool for teaching General Anatomy.

REFERENCES

- Arumugam, N., Suppiah, P., Manap, M., & Munchar. (2022). Use of animation in classrooms at higher learning institutions: Student perception. *Global Academic Journal of Linguistics and Literature*, 4(4), 111–118. https://www.gajrc.com/media/articles/GAJLL_44_111-118_FT.pdf
- Ding, Z., Miao, J., Yong, Y., & Zhu, W. (2024). Impact of 3D learning resources on learning resilience: Mediating roles of positive emotion and cognitive load. *Humanities and Social Sciences Communications*, 11, Article 1125. <https://www.nature.com/articles/s41599-024-03544-x>
- Ha, J., & Choi, D. (2019). Educational effect of 3D applications as a teaching aid for anatomical practice for dental hygiene students. *Archives of Craniofacial Surgery*, 20(6), 370–374. <https://pubmed.ncbi.nlm.nih.gov/articles/PMC6952687/>
- Ibadullayev, A. (2025). *3D modelling in education*. ResearchGate. https://www.researchgate.net/publication/392922677_3D_MODELING_IN_EDUCATION
- Kılıç, M., Yurtsever, A., Açıkgöz, F., Başgut, B., Mavi, B., Ertuç, E., Sevim, S., Oruk, T., Kıyak, Y., & Peker, T. (2025). A new classmate in anatomy education: 3D anatomical modeling medical students' engagement on learning through self-prepared anatomical models. *Anatomical Sciences Education*. <https://pubmed.ncbi.nlm.nih.gov/40528565/>
- Lam, A., & Su, Y. (2016). *A study on experimental teaching of 3D animation*. ResearchGate. https://www.researchgate.net/publication/306063540_A_study_on_experimental_teaching_of_3D_animation
- Rashid, N., Khanum, N., & Rahim, F. (2024). The effect of animation as a teaching tool on students' learning: An experimental study. *Multidisciplinary Advances in Language, Education, and Research*, 5(2), 70–84. https://www.mlar.sk/wp-content/uploads/2024/06/7_Rashid-1.pdf
- Rohman, S. (2024). *The development of animation video-based learning material by combining mobile applications for teaching English at the secondary level*. The International Academic Forum (IAFOR). https://papers.iafor.org/wp-content/uploads/papers/acah2024/ACAH2024_80622.pdf
- Saufi, S. (2025). From traditional classrooms to digital learning: Exploring research trends in contemporary e-learning challenges education. *SunText Reviews*, 6(1), Article 086. <https://suntextrreviews.org/doi/pdf/10.51737/2766-4600.2025.086>
- Scott, J., & Donald, G. (2024). *Diversity in learning styles*. ResearchGate. https://www.researchgate.net/publication/385895494_Diversity_in_Learning_Styles
- Sharma, G., Bheda, R., & Rawal, K. (2025). A study on the usage of animation as a pedagogical tool in teaching pre-primary & primary schools in Mumbai. *Journal of Medical Science and Research*, 13(2), 45–52. <https://jmsr-online.com/article/a-study-on-the-usage-of-animation-as-a-pedagogical-tool-in-teaching-pre-primary-primary-schools-in-mumbai-185/>
- Spiriev, T., Mitev, A., Stoykov, V., Dimitrov, N., Maslarski, I., & Nakov, V. (2022). Three-dimensional immersive photorealistic layered dissection of superficial and deep back muscles: Anatomical study. *Cureus*, 14(7), Article e27898. <https://pubmed.ncbi.nlm.nih.gov/35967185/>

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- Szabo, T., & Zitný, R. (2026). The use of animation in educational process. *Research in Subject-matter Education*, 7(1), 12–25. <https://journal.ph-noe.ac.at/index.php/resource/article/view/1546>
- Teplá, M., Teplý, P., & Šmejkal, P. (2022). *Influence of 3D models and animations on students in natural subjects*. ResearchGate.
https://www.researchgate.net/publication/364349916_Influence_of_3D_models_and_animations_on_students_in_natural_subjects
- Vyas, M. (2023). *Traditional learning students insights*. ResearchGate.
https://www.researchgate.net/publication/373603187_Traditional_Learning_Students_insights
- Yang, J., Sun, Y., Wang, L., Yang, S., & Zhang, J. (2025). Difficulty-based three-dimensional animation in oral histology and embryology education: An explorative study. *European Journal of Dental Education*, 29(2), 310–319. <https://onlinelibrary.wiley.com/doi/full/10.1111/eje.70006>