Scientific Research Publishing

Forensic Medicine and Anatomy Research, 2024, 12, 13-25
https://www.scirp.org/journal/fmar
ISSN Online: 2327-4107
ISSN Print: 2327-4115

Opinions of Students on the Contribution of the DIVA 3D Virtual Dissection Table to the Teaching of Anatomy at the Faculty of Medicine and Odontostomatology of Bamako

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How to cite this paper: Kanté, A., Touré, T., Haidara, O.T.C., François, U.J., Daou, M., Keita, M.A., Keïta, B., Bengaly, B., Traoré, D., Togo, A. and Ongoïba, N. (2024) Opinions of Students on the Contribution of the DIVA 3D Virtual Dissection Table to the Teaching of Anatomy at the Faculty of Medicine and Odontostomatology of Bamako. *Forensic Medicine and Anatomy Research*, **12**, 13-25.
https://doi.org/10.4236/fmar.2024.122002

Received: January 15, 2024
Accepted: April 27, 2024
Published: April 30, 2024

Abstract

Objective: Study the contribution of the DIVA 3D dissection table in the teaching of anatomy at the Faculty of Medicine and Odontology of Bamako. **Material and Methods:** This was a qualitative study carried out from November 1 to December 30, 2023 at the clinical and morphological anatomy laboratory of the Faculty of Medicine and Odontostomatology of Bamako. Included in this study were students who participated in practical and tutorial sessions. The variables studied during this study were: the previous performance of dissection on a cadaver by the students, the opinion of the students on dissection on a cadaver, the replacement of dissection on a cadaver by virtual dissection in the absence of a body, the level student satisfaction. **Results:** We surveyed 130 participants. The average age was 22 ± 0.2 years with extremes of 17 and 29 years. 95.3% of participants were students. According to 66.7% of participants, virtual dissection is a good palliative in the absence of a corpse. 95.3% of participants found using the virtual dissection table easy with an average of 7.88 ± 1.4. The overall assessment was well rated by 99.3% of participants. **Conclusion:** According to the results of this study, the virtual dissection table should be improved by integrating commented videos. The use of the DIVA 3D virtual dissection table during practical and tutorial sessions is well appreciated by the students. We believe that the teaching of

anatomy using 3D digital technology should be included in the study programs of the Faculty of Medicine and Odontostomatology.

Keywords

Student Opinion, Contribution, DIVA 3D Virtual Dissection Table, Anatomy Teaching, FMOS

1. Introduction

We have now entered the digital age. It is a true technological revolution from which morphological science is not immune.

Indeed, 3D modeling of human anatomy is a remarkable educational tool for teaching and understanding morphology. The future of surgery is also linked to this modeling to carry out simulations, repeat surgical interventions or access augmented reality: modern surgery is surgery guided by images and the 3D model.

Training in human anatomy is essential at all stages of the practice of medicine: the clinical examination, the interpretation of medical images and the surgical procedure are based on knowledge of the anatomy of the human body. The acquisition of these skills is initially theoretical then practical with dissection.

Certainly, cadaveric dissection is the gold standard of knowledge in anatomy, on the other hand it presents significant disadvantages: the lack of cadavers which cannot cover the demand of medical schools, the limited location of the activity (theater anatomical) and the fact that dissection is unique because it is based on a destructive and irreversible process on human tissues, finally ethical and religious problems.

For all these reasons, the 3D reconstruction of anatomical structures promotes new educational methods widely used around the world, for their new realistic and interactive interfaces.

It is a wonderful tool for students wanting to learn about the human body, but also for anatomy teachers and for interactive clinical simulation for practitioners [1] [2]. Finally, it is a revolution for surgeons: assistance with preoperative planning, simulation and augmented reality to guide the surgical procedure.

3D digital anatomy opens a new way of teaching anatomy thanks to the digital nature of the data allowing quantitative morphological analysis within the framework of computational anatomy [3] [4].

This also opens up a new way for young people to learn anatomy: by manually drawing the boundaries of anatomical structures on sections, they build 3D models which allow in-depth learning, the use of these models coupled with techniques of immersive reality produces a strong emotional impact on the learning process.

For two years, the Faculty of Medicine and Odontology of the University of Sciences, Techniques and Technologies of Bamako has had a virtual dissection

table called DIVA 3D.

This virtual dissection table integrates the 3D reconstruction of all the organs of the human body and is used during practical and supervised work by secondary medicine students at the Faculty of Medicine and Odontostomatology in Bamako.

We initiated this work in order to study the contribution of this virtual dissection table to the teaching of anatomy.

The research question is as follows: would the use of the DIVA 3D virtual dissection table improve the teaching of anatomy at the Faculty of Medicine and Odontostomatology of the University of Sciences, Techniques and Technologies from Bamako?

The research hypothesis to be verified is as follows: "At least 80% of students at the Faculty of Medicine and Odontostomatology are satisfied with the use of the DIVA 3D virtual dissection table during practical and supervised work".

Main objective

Evaluate students' opinions on the contribution of the DIVA 3D virtual dissection table to the teaching of anatomy at the Faculty of Medicine and Odontostomatology of Bamako.

Specific objectives

Determine the advantages of the DIVA 3D virtual dissection table compared to cadaveric dissection based on student opinion.

Identify the limitations of the DIVA 3D virtual dissection table based on student opinion.

2. Materials and Methods

2.1. Materials

The DIVA 3D virtual dissection table (see Figures 1-3) is an educational tool

Figure 1. Virtual dissection table interface screen. On the left the 3D window. On the right, the function buttons to choose the display and the mode to be selected by zone, device, system, organ and/or slice.

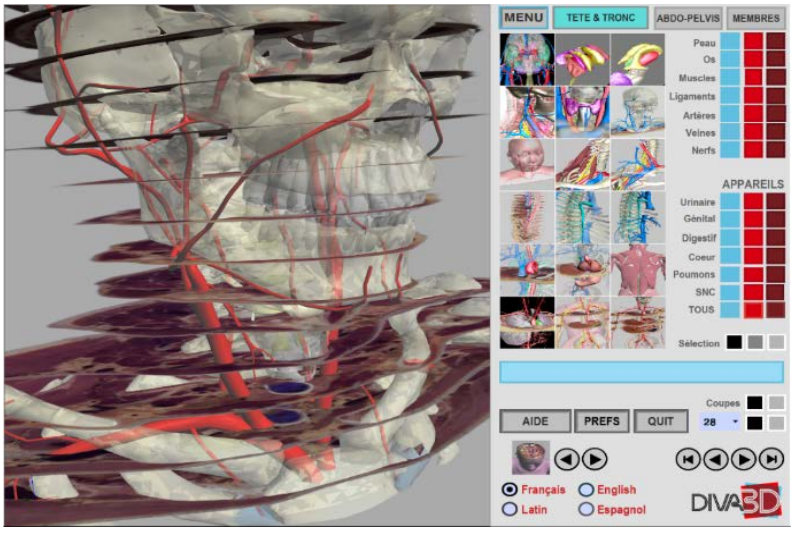

Figure 2. Virtual dissection table interface screen. On the left the 3D window showing the axial sections of the neck. On the right, the function buttons to choose the display and the mode to be selected by zone, device, system, organ and/or slice.

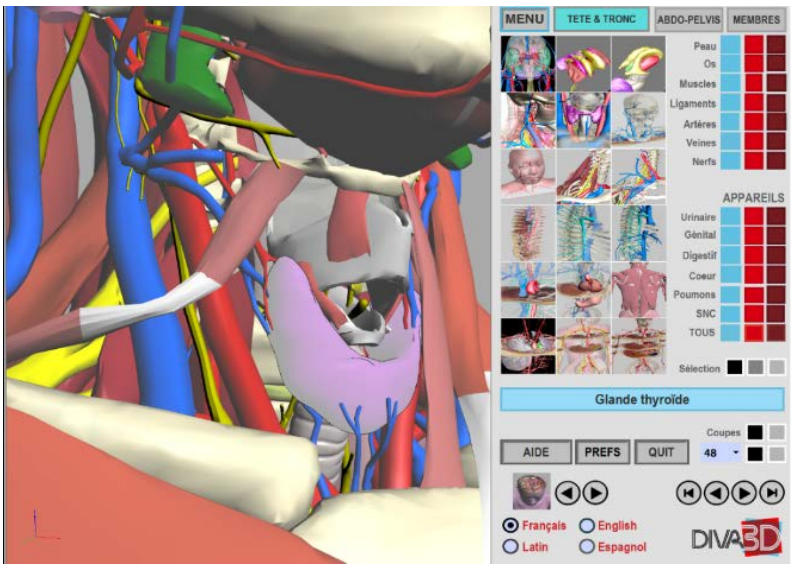

Figure 3. Virtual dissection table interface screen. On the left the 3D window. On the right, the function buttons to choose the display and the mode to be selected by zone, device, system, organ and/or slice. The thyroid gland is highlighted in the blue rectangle.

combining the 3D reconstruction of the entire body of a 33-year-old Korean man and that of a 25-year-old woman who donated their bodies to science. It was designed at the clinical and digital anatomy laboratory in Paris.

It includes a monitor with multi-point touch frame, a monitor stand on wheels, a Mac mini 8G computer, mounting bracket and connectors and an interactive atlas software suite for men and women (Acrobat 3DPDF files).

2.2. Methods

This was a cross-sectional and qualitative study. It was carried out from No-

vember 1 to December 30, 2023 in the morphological and clinical anatomy laboratory of the Faculty of Medicine and Odontostomatology (FMOS) of the University of Sciences, Techniques and Technologies of Bamako (USTTB).

The target population was composed of students from the Faculty of Medicine and Odontostomatology of the University of Sciences, Techniques and Technologies of Bamako.

The source population consisted of students enrolled in the second year of medicine at the Faculty of Medicine and Odontostomatology at the University of Sciences, Techniques and Technologies of Bamako.

Students enrolled in the second year of medicine at the USTTB FMOS were included in this study, having participated in the practical and supervised work sessions and having completely completed the survey sheets.

Students from other FMOS promotions and those from the Faculty of Pharmacy were not included in this study.

Students in the second year of medicine who did not participate in the practical and supervised work sessions and who did not completely complete the survey form were excluded from the study.

We used several variables during our study. The main variables were the advantages of the DIVA 3D virtual dissection table and the limitations of the DIVA 3D virtual dissection table.

The advantages of the DIVA 3D dissection table were judged on the following variables: ease of use of the virtual dissection table, simplicity of the interface of the virtual dissection table and graphic quality of the virtual dissection table DIVA 3D.

The limitations of the DIVA 3D virtual dissection table were judged on the criticisms made by the students against the dissection table, the addition and removal of features to the virtual dissection table proposed by the students and the overall satisfaction level of the students.

The sampling was exhaustive. These were students from the second year of the Faculty of Medicine and Odontostomatology of the University of Sciences, Techniques and Technologies of Bamako.

The sample size was the number of students enrolled in the second year of medicine. After studying the survey sheets and checking student participation in the practical and tutorial sessions, we retained 130 students.

A standardized questionnaire inspired by several national and international questionnaires on evaluations of educational materials and on opinion surveys was used. This tool was tested and adapted before data collection.

The team was made up of two investigators responsible for explaining the questionnaires to students, monitoring and verifying the completeness of the data. The questionnaires were completed by the students just after the cadaveric and virtual dissection sessions in the anatomy laboratory.

A pretest was carried out on a sample of ten students before the start of the survey and adjustments were made. A finalization at the end of the practical and supervised work was done within the data collection team.

Data analysis was carried out with R.4.0.4 software. The tables and figures were produced with Microsoft Office Word and Excel version 2016 software. The medians were presented with their interquartile ranges and the proportions with their confidence intervals.

Ethical considerations

Informed and free consent from each student subjected to the study was obtained. Students were informed of the confidentiality of the data collected. The data was processed anonymously. The protocol was approved by the Director of the anatomy laboratory of the Faculty of Medicine and Odontostomatology of the University of Sciences, Techniques and Technologies of Bamako.

3. Results

3.1. General Characteristics of Students

We surveyed 130 students enrolled in the second year of medicine on the contribution of the DIVA 3D virtual dissection table to the teaching of anatomy (Figures 4-6).

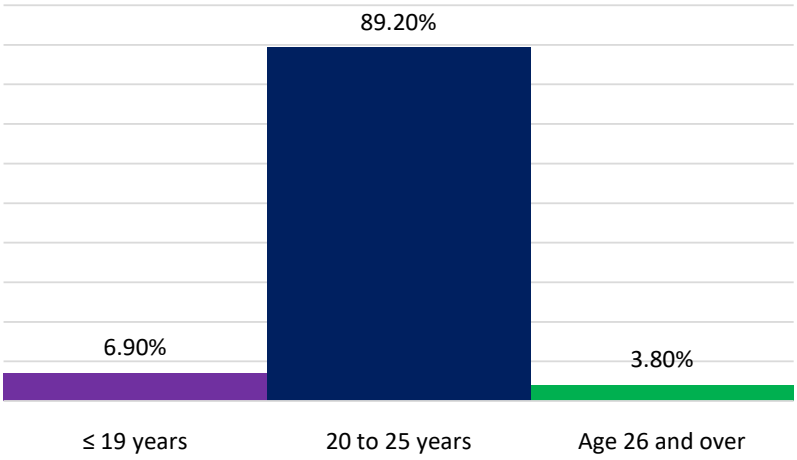

Figure 4. Age range of participants in the opinion survey on the contribution of the DIVA 3D virtual dissection table to the teaching of anatomy at the Faculty of Medicine and Odontostomatology of Bamako on November 1 as of December 30, 2023.

The average age was 22 ± 0.2 years with extremes of 17 and 29 years.

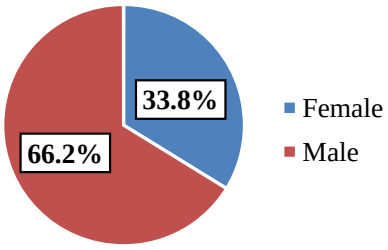

Figure 5. Gender of participants in the opinion survey on the contribution of the DIVA 3D virtual dissection table to the teaching of anatomy at the Faculty of Medicine and Odontostomatology of Bamako from November 1 to December 30 2023.

The sex ratio was 1.9.

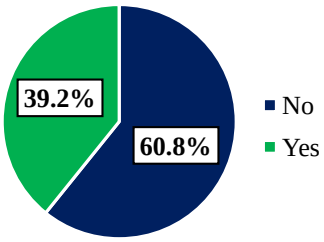

Figure 6. Distribution of participants according to whether the dissection was carried out on a cadaver.

The cadaver dissection was carried out by 51 participants or 39.2.

3.2. Advantages of the DIVA 3D Virtual Dissection Table According to Student Opinions (Figure 7, Figure 8)

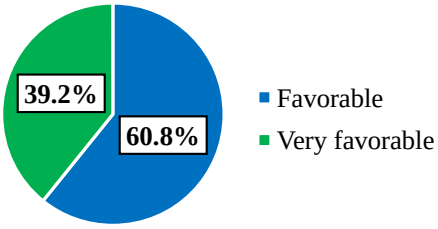

Figure 7. Student opinion on cadaveric dissection during the opinion survey on the contribution of the DIVA 3D virtual dissection table to the teaching of anatomy at the Faculty of Medicine and Odontostomatology of Bamako du November 1 to December 30, 2023.

Among the 51 participants who had already performed cadaveric dissection, 60.8% were favorable to the practice of cadaveric dissection and 15.4% were very favorable.

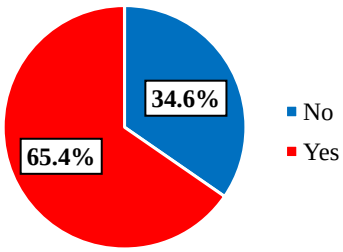

Figure 8. Opinions of students on the replacement of cadaveric dissection by virtual dissection during the opinion survey on the contribution of the DIVA 3D virtual dissection table to the teaching of anatomy at the Faculty of Medicine and odontostomatology in Bamako from November 1 to December 30, 2023. According to 65.4% of participants, virtual dissection is a good palliative.

In the study, 43 participants had already used virtual dissection software/application, *i.e.* 33.1%. The main software/applications used were Anatomie 3D (41.9%), Atlas (27.9%). Smartphones were the medium of use in 83.7% (**Figure 9**).

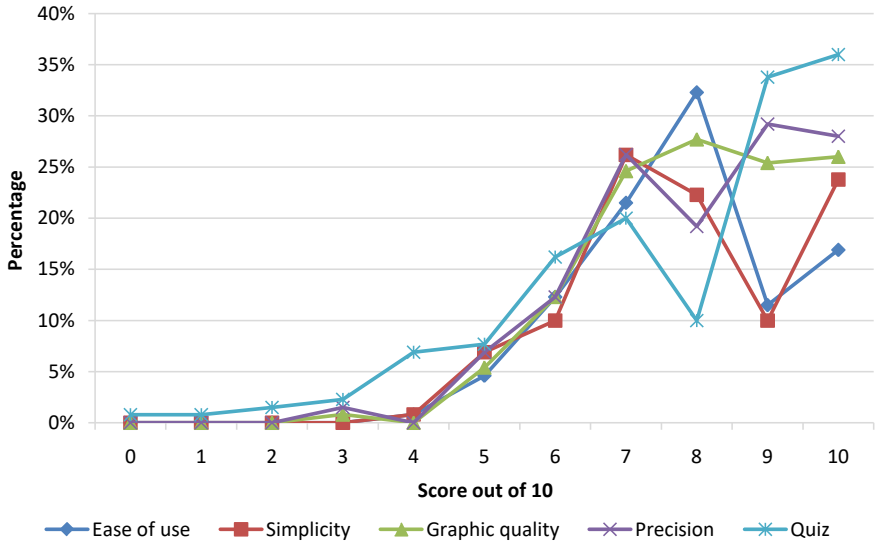

Figure 9. Appreciation of the DIVA3D virtual dissection table by students during the opinion survey on the contribution of the DIVA 3D virtual dissection table to the teaching of anatomy at the Faculty of Medicine and odontostomatology in Bamako from November 1 to December 30, 2023.

Compared to the appreciation of the DIVA3D virtual dissection table, 94.6% of participants found it easy with an average of 7.82 ± 1.4; 95.4% found the interface easy to use (average = 7.90 ± 1.6); a good quality graph (mean ± SD = 8.40 ± 1.4); 93.8% found good anatomical accuracy (mean ± SD = 8.30 ± 1.6); the quiz was well rated by 87.7% (mean ± SD = 8.0 ± 2.0). The overall assessment was well rated by 99.3% of participants with a mean ± SD = 9.0 ± 1.2.

3.3. The Limits of the DIVA 3D Virtual Dissection Table According to the Opinions of the Students (Tables 1-3, Figure 10)

Table 1. Criticisms formulated by students against the DIVA 3D virtual dissection table during the opinion survey on the contribution of the DIVA 3D virtual dissection table to the teaching of anatomy at the Faculty of Medicine and of odontostomatology in Bamako from November 1 to December 30, 2023.

Criticisms from students	Effective	Percentage
None	94	72.3
Slow software	18	13.8
Improved image quality	3	2.3
Change of old names	1	0.8
Difficult handling	2	1.5
Requires computer skills	11	8.5
Preference of cadaveric dissection	1	0.8
Total	**130**	**100.0**

Thirty-six participants (27.7%) expressed criticism against the DIVA 3D virtual dissection table.

Table 2. Proposals for adding functionalities to the DIVA 3D virtual dissection table, made by students during the opinion survey on the contribution of the DIVA 3D virtual dissection table to anatomy teaching at the Faculty of Medicine and odontostomatology of Bamako from November 1 to December 30, 2023.

Added features	Effective	Percentage
None	85	65.4
Audio	16	12.3
Improved speed of the dissection table	10	7.7
Adaptation to training levels	4	3.1
Added new organ names	2	1.5
Insertion of dissection planes	2	1.5
Precision of different cuts	2	1.5
Improvement of the cardiovascular system	1	0.8
Different anatomical cuts	1	0.8
Added anatomical variations	1	0.8
Function and vascularization of each organ	1	0.8
Precise position of the viscera	2	1.5
Accuracy of the name of the different structures	1	0.8
Improved vascularization	2	1.5

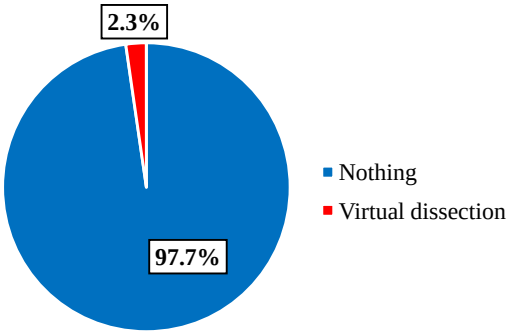

Figure 10. Opinions of students on the replacement of cadaveric dissection by virtual dissection during the opinion survey on the contribution of the DIVA 3D virtual dissection table to the teaching of anatomy at the Faculty of Medicine and odontostomatology in Bamako from November 1 to December 30, 2023.

Table 3. Comments made by students on the DIVA 3D virtual dissection table during the opinion survey on the contribution of the DIVA 3D virtual dissection table to the teaching of anatomy at the Faculty of Medicine and of odontostomatology in Bamako from November 1 to December 30, 2023.

Comments on the DIVA3D dissection table	Effective	Percentage
Excellent	114	87.6
Make the table accessible to students	6	4.6
Very good but cannot replace a body	5	3.8
Make the table more realistic	1	0.8

Continued

The sessions are very informative	1	0.8
Can replace the corpse with more importance	1	0.8
More understandable than theoretical courses	1	0.8
Integration of theoretical courses into the virtual dissection table	1	0.8
Total	**130**	**100.0**

4. Discussion

4.1. Work Limit

The questionnaire was administered by the practical and supervised work supervisors. This would likely have influenced the students' response.

4.2. Comparison with Other Authors

The study of anatomy is one of the most important steps in the education of medicine and health sciences [5]. Anatomy is difficult for students to learn because teaching is based on visualization and memory [6]. It is generally accepted that teaching on models and cadavers is carried out in the laboratory alongside theoretical teaching in the classroom [7]. Although cadaver dissection is an integral part of anatomy education, some medical schools prefer not to use them for ethical reasons [8]. In countries where cadaver donations are rare [9], the teaching of anatomy through dissection is not practiced and relies solely on models.

During our survey, 60.8% of second year medical students had not previously performed cadaver dissection. This rate could be explained by the fact that there is no practical and supervised work in the first year of medicine; this is because of the overabundance of more than 3000 first-year students.

With technological advancement, the use of smartphones, tablets and computers has become habitual. Great effort has been made to find innovative methods to create, visualize and animate high-quality content to aid learning. These innovative methods then speak of content personalization, content interaction and movement, as well as immersion or intuitive learning [10]. Students at the Faculty of Medicine and Odontostomatology in Bamako do not benefit greatly from this technological advance. In fact, only 43 students (33.1%) out of 130 used this technology to learn anatomy. This rate is lower than that reported by Jaffar who found that 98% of students used YouTube as an online platform and this increased their success in anatomy tests by 9%.

The low rate of use of virtual dissection by students at the Faculty of Medicine and Odontostomatology of Bamako could be explained by the accessibility of connections.

Despite this low rate of use of virtual dissection, 97.7% of students wanted to replace cadaveric dissection with the DIVA 3D virtual dissection table.

Their wish could be explained by their overall appreciation of the DIVA 3 virtual dissection table. Indeed, 94.6% of students found that the DIVA 3D virtual dissection table was easy to use and 95.4% found it Simple to use interface. In addition to these benefits, students rated the anatomical accuracy of the DIVA 3D virtual dissection table at 93.8%. Their overall appreciation of the DIVA 3D virtual dissection table was 99.3%.

However, 13.8% of students found it slow and 1.6% found it difficult to operate. Thus, 12.8% suggested the integration of dissection videos into the DIVA 3D virtual dissection table and 0.8% proposed the addition of anatomical variations. We believe that these suggestions made by students should be taken into account in order to improve the DIVA 3D virtual dissection table.

This new version should aim to be at least equal to the Anatomage table [11] (see **Figure 11**), a human-scale table allowing interaction with an annotated 3D anatomical model. By using a virtual scalpel and cutting planes, this table makes it possible to isolate anatomical structures and navigate between more or less deep anatomical layers. The model used can be changed depending on educational needs (e.g.: Female model, male model, model with specific health conditions, etc.). The virtual allows the use of an infinite model and allows us to be confronted with varied or even very rare cases.

The literature described a human anatomy teaching (HAE) channel on YouTube to support visualization in anatomy classes with videos, and showed that 98% of students used YouTube as an online information source. The authors said YouTube videos should be included in anatomy teaching [12].

The increase in digital literature and students' interest in digital technologies has attracted the attention of researchers. A study showed that teaching digital anatomy could be usefully combined with traditional methods. The authors also believe that teaching digital anatomy combined with traditional teaching is the best alternative [13]. In a SWOT analysis of teaching digital anatomy, the section

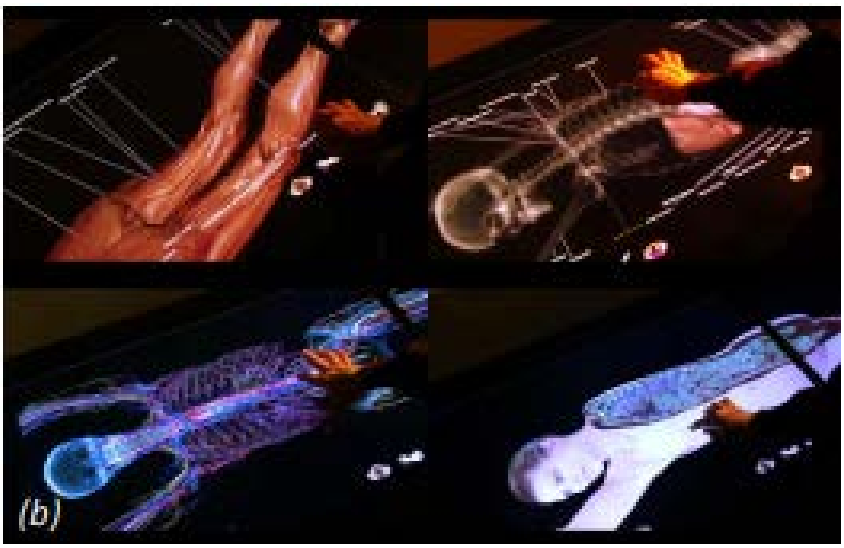

Figure 11. Table de dissection virtuelle Anatomage—2012.

on opportunities indicated that digital teaching materials are accessible at any time, open to updating and innovation, and that teaching of Anatomy becomes more interesting with technology [14]. Another study used a blended learning approach including pre-recorded dissection videos, offline cadaver dissection, and 3D anatomy applications. It showed that the best alternative for teaching anatomy is a mixture of 3D and video-assisted education [15]. In our study, we did not compare anatomical dissection by the DIVA 3D virtual dissection table with traditional cadaveric dissection, we wanted to separately study the advantages and limitations of the DIVA 3D virtual dissection table according to the opinions of the students. Some research has produced a free mobile phone application (Qlone) in response to the cost of 3D technology used in online courses. In this study, 53 bones were scanned and converted into 3D software.

A study comparing 3D anatomy teaching with traditional methods used three different approaches: computer-assisted 3D, 3D augmented reality, and 3D virtual reality. The successes of these approaches have been ranked as follows: computer-assisted reality is superior to the augmented-assisted 3D method which is superior to the traditional method.

Other studies [16] indicated that 3D teaching should be included in current anatomy teaching.

5. Conclusions

According to the results of this study, the virtual dissection table should be improved by integrating commented videos.

The use of the DIVA 3D virtual dissection table during practical and tutorial sessions is well appreciated by the students. We believe that the teaching of anatomy using 3D digital technology should be included in the study programs of the Faculty of Medicine and Odontostomatology.

Indeed, students indicated a preference for virtual dissection rather than cadaveric dissection during practical and supervised work. A comparative study of the two methods (cadaveric dissection and virtual dissection) should be explored in future studies.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Ackerman, M.J. (1999) The Visible Human Project. A Resource for Education. *Academic Medicine*, **74**, 667-670. https://doi.org/10.1097/00001888-199906000-00012

[2] Cho, Z.H. (2009) 7.0 Tesla MRI Brain Atlas, *In Vivo* Atlas with Cryomacrotome Correlation. Springer, New York. https://doi.org/10.1007/978-1-60761-154-7

[3] Cho, Z.H., Calamate, F. and Chi, J.G. (2012) 7.0 Tesla MRI Brain White Matter Atlas. Panmun, Seoul.

[4] Uhl, J.H., Mogorron, J., and Chahim, M. (2021) The Virtual Dissection Table: A 3D Atlas of the Human Body Using Vectorial Modeling from Anatomical Slices. In Digital Anatomy. Applications of Virtual, Mixed and Augmented Reality. Springer, Paris, 108. https://doi.org/10.1007/978-3-030-61905-3_6

[5] Sugand, K., Abrahams, P. and Khurana, A. (2010) The Anatomy of Anatomy: A Review for Its Modernization. *Anatomical Sciences Education*, **3**, 83-93. https://doi.org/10.1002/ase.139

[6] Wickramasinghe, N., Thompson, B. R. and Xiao, J. (2022) The Opportunities and Challenges of Digital Anatomy for Medical Sciences: Narrative Review. *JMIR Medical Education*, **8**, e34687. https://doi.org/10.2196/34687

[7] Singal, A. (2022) Transforming Anatomy Education: Then and Now. *Anatomical Science International*, **97**, 230-231. https://doi.org/10.1007/s12565-021-00645-4

[8] Barteit, S., Lanfermann, L., Bärnighausen, T., Neuhann, F. and Beiersmann, C. (2021) Augmented, Mixed, and Virtual Reality-Based Head-Mounted Devices for Medical Education: Systematic Review. *JMIR Serious Games*, **8**, e29080. https://doi.org/10.2196/29080

[9] Habicht, J.L., Kiessling, C. and Winkelmann, A. (2018) Bodies for Anatomy Education in Medical Schools: An Overview of the Sources of Cadavers Worldwide. *Academic Medicine*, **93**, 1293-1300. https://doi.org/10. 1097/ACM.0000000000002227

[10] Attardi, S.M., Harmon, D.J., Barremkala, M., Bentley, D.C., Brown, K.M., Dennis, J.F., Goldman, H.M., Harrell, K.M., Klein, B.A., Ramnanan, C.J. and Farkas, G.J. (2022) An Analysis of Anatomy Education before and during Covid-19: August-December 2020. *Anatomical Sciences Education*, **15**, 5-26. https://doi.org/10.1002/ase.2152

[11] Anatomage (2012) http://medical.anatomage.com

[12] Jaffar, A.A. (2012) YouTube: An Emerging Tool in Anatomy Education. *Anatomical Sciences Education*, **5**, 158-164. https://doi.org/10.1002/ase.1268

[13] Xiao, J. and Evans, D.J.R. (2022) Anatomy Education beyond the Covid-19 Pandemic: A Changing Pedagogy. *Anatomical Sciences Education*, **15**, 1138-1144. https://doi.org/10.1002/ase.2222

[14] Wickramasinghe, N., Thompson, B.R. and Xiao, J. (2022) The Opportunities and Challenges of Digital Anatomy for Medical Sciences: Narrative Review. *JMIR Medical Education*, **8**, e34687. https://doi.org/10.2196/34687

[15] Yoo, H., Kim, D., Lee, Y. M. and Rhyu, I.J. (2021) Adaptations in Anatomy Education during COVID-16. *Journal of Korean Medical Science*, **36**, e13. https://doi.org/10.3346/jkms.2021.36.e13

[16] Triepels, C.P.R., Smeets, C.F.A., Notten, K.J.B., Kruitwagen, R.F.P.M., Futterer, J.J., Vergeldt, T.F.M. and van Kuijk, S.M.J. (2020) Does Three-Dimensional Anatomy Improve Student Understanding? *Clinical Anatomy*, **33**, 25-33. https://doi.org/10.1002/ca.23405