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Virtual Reality: Re-Introducing Anatomy to the 21st Century

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Virtual Reality: Re-Introducing Anatomy to the 21st Century

Summary

The exponential progress of technology has led to an explosion of computer-based learning tools in the field of gross anatomical education. At the forefront of the classroom revolution are three-dimensional (3D) models. Publishers such as Elsevier are leading the foray and now offer fully interactive 3D models for purchase. With the current state of anatomical education, the addition of 3D anatomy on top of a crowded schedule can be daunting. Haphazard use can lead to student dissatisfaction and negative feedback. Through the use of research articles, we sought to discuss the advantages and disadvantages as well as highlight some the challenges that come with 3D anatomy. This seminar seeks to provide insight to anatomy educators on the proper implementation, seamless integration, and effective use of 3D anatomy in today's anatomy laboratory.

Keywords

gross anatomy, three-dimensional (3D) model, 3D anatomy, laboratory, computer-based learning, implementation

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Virtual Reality: Re-Introducing Anatomy to the 21st Century

SUMMARY

The exponential progress of technology has led to an explosion of computer-based learning tools in the field of gross anatomical education. At the forefront of the classroom revolution are three-dimensional (3D) models. Publishers such as Elsevier are leading the foray and now offer fully interactive 3D models for purchase. With the current state of anatomical education, the addition of 3D anatomy on top of a crowded schedule can be daunting. Haphazard use can lead to student dissatisfaction and negative feedback. Through the use of research articles, we sought to discuss the advantages and disadvantages as well as highlight some the challenges that come with 3D anatomy. This seminar seeks to provide insight to anatomy educators on the proper implementation, seamless integration, and effective use of 3D anatomy in today's anatomy laboratory.

Keywords: gross anatomy, three-dimensional (3D) model, 3D anatomy, laboratory, computer-based learning, implementation

LEARNING OBJECTIVES

After this seminar, attendees will be able to:

- Identify the advantages and disadvantages of 3D anatomy models when used in an instructional setting
- Define stereoscopy and evaluate its need in the anatomy laboratory
- Identify the challenges involved with the implementation, integration, and use of 3D anatomy models

REFERENCE SUMMARIES

Drake, R.L., McBride, J.M., Lachman, N. & Pawlina, W. (2009). Medical education in the anatomical sciences: The winds of change continue to blow. *Anatomical Sciences Education*, 2, 253-259.

Drake et al. surveyed 130 allopathic and 25 osteopathic medical schools to determine the current state of anatomical education in the United States. Survey responses provided information on the number of hours allocated to gross anatomy and associated anatomical sciences (histology, embryology, etc.) as well as information on how each course is taught. Current data was compared to data in anatomical education reviews from 1955 to 2002 to track the recent progression of anatomy education. Since 1955, Drake et al. noted that the number of hours allocated for gross anatomical education has decreased significantly. However, further examination of the data reveals that since 1973, the rate of decrease in the number of hours has slowed, suggesting a stabilization of number of hours. Furthermore, the general structure of gross anatomical education seems to have

undergone little change as the role of the laboratory and the percentage of hours devoted to lectures have remained fairly constant. It is important to note that educators recognize the necessity of a laboratory component in gross anatomical education. This article serves to provide the status and structure of gross anatomy courses in today's medical curriculum.

Hasan, T., Ageely, H. & Bani, I. (2011). Effective anatomy education – a review of medical literature. *Rawal Medical Journal*, 36(3), 233-237.

From a pool of over 800 articles published between 1972 and 2011, Hasan et al. reviewed 180 articles for their relevance to methods of anatomy instruction and their pedagogic significance. The research team from Saudi Arabia aimed to review the use of instructional aids in anatomical education and the potential of these methods. Hasan et al. provide a broad perspective on the role technology plays in anatomical education today and highlights some of the areas of strength and weakness which need to be addressed by educators. In the conclusion of their review, Hasan et al. note that none of the new technological modalities can be strictly labelled as superior or inferior for teaching and learning anatomy. They suggest implementing multiple resources instead of using one medium to deliver the content. New technological advances should complement traditional methods rather than compete with them.

Mayer, R.E. (2010). Applying the science of learning to medical education. *Medical Education*, 44, 543-549.

Richard Mayer discusses the cognitive theory of multimedia learning and how it applies to medical education. Although not specific to gross anatomy, this article provides valuable insight into the pitfalls of multimedia use in education. Mayer argues that meaningful learning occurs through proper cognitive processing of the content. Through outlining the principles of the cognitive theory of multimedia learning, Mayer provides educators with the information to create effective multimedia teaching tools. This is especially relevant to 3D anatomy as creators often overwhelm students with the amount of information they are able to show on a given model. The principles provided create boundaries and caution educators against overwhelming their audience, ensuring that students maximize the potential of a given multimedia source.

Cohen, M., da Costa Astur, D., Kaleka, C.C., Arliani, G.G., Cohen, C., Jalikjian, W. & Golano, P. (2011) Introducing 3-Dimensional Stereoscopic Imaging to the Study of Musculoskeletal Anatomy. *Arthroscopy: The Journal of Arthroscopic and Related Surgery*, 27(4), 593-596.

Stereoscopy is usually an issue raised when discussing 3D anatomy. Cohen et al., based in Sao Paulo, Brazil, formally introduce their stereoscopic 3D musculoskeletal models as well as provide information on the development of the tools. Stereoscopy is a three-dimensional view that allows a real sense of depth. The major benefit of this view of anatomical models is that it provides a more precise orientation of the structure. Through manipulation of the binocular visual system, technicians are able to overlay images to produce an image in three dimensions. The article continues to describe the process of developing the stereoscopic images through the anaglyph (red/cyan method). This method

allows images to be printed and used in presentations. Stereoscopic 3D anaglyphic film development is also described by Cohen et al. This article provides readers with insight into the development process of 3D models.

Nguyen, N. & Wilson, T.D. (2009). A head in virtual reality: development of a dynamic head and neck model. *Anatomical Science Education*, 2, 294-301.

Nguyen & Wilson describe another process through which stereoscopic 3D models can be made. The article follows the development of a dynamic stereoscopic 3D head and neck model from data acquisition through to the final model. Using computed tomography scans of a human cadaver, Nguyen & Wilson describe their use of computer software to segment anatomical structures and develop the 3D surfaces of a model. This article also discusses many of the limitations of 3D models. Issues discussed include type of starting data, identification of structures, technical issues and cost of computer hardware and software. Along with the previous article (Cohen et al.), this article provides instruction on the development of the 3D models as well as some of the associated challenges.

Codd, A.M. & Choudhury, B. (2011). Virtual reality anatomy: Is it comparable with traditional methods in the teaching of human forearm musculoskeletal anatomy? *Anatomical Science Education*, 4, 119-125.

Comparisons between traditional gross anatomical education and new 3D models have exploded as the availability of new technologies has increased. Codd & Choudhury sought to evaluate a 3D model of the forearm muscles against traditional teaching media (dissection and textbooks). Neither the 3D model nor the traditional methods experimental groups performed significantly better. Feedback from all users exposed to the 3D model was positive. Despite the similar outcomes of the two educational methods, the authors do not suggest replacing traditional media with 3D models due to the loss of tactile information as well as the lack of anatomical variation. Codd & Choudhury state that 3D models should be used in conjunction with traditional methods.

Silen, C., Wirell, S., Kvist, J., Nylander, E. & Smedby, O. (2008). Advanced 3D visualization in student-centred medical education. *Medical Teacher*, 30, 115-124.

Through responses to questionnaires, Silen et al. sought students' opinions on the possible educational value of 3D visualization. Silen et al. reported that 3D anatomy helped stimulate students' learning. It provided insights into the spatial orientation and relationship of given structures. The authors echo similar thoughts on 3D anatomy's role within the gross anatomy course. The authors conclude a few key points to be considered when implementing and using 3D anatomy:

- Authentic 3D models and films can be used to allow students to view a new dimension of anatomy.
- 3D models should be implemented in the pre-existing educational themes in congruence with traditional methods.

- Successful implementation of 3D anatomy requires the educators' involvement during all stages of the process.
- Students require time to acclimate to new educational media.

Attendees of this seminar will be provided with the above resources for their perusal prior to the start of the seminar.

CONTENT & ORGANIZATION

Total Time 90 minutes (can be adjusted for audience size)

Time	Topic	Description
5 min	Welcome, introduction	<p>Topics to be covered during the day will be introduced through an introduction from the main speaker.</p> <p>If the audience is large, a few members from the audience can be polled to introduce themselves as well as provide reasons why they have chosen to attend this seminar and what they would like to achieve.</p> <p>If the audience is small enough, people may sit in a more inclusive format and may introduce themselves and provide reasons why they are interested in the topic and what they would like to get out of the seminar.</p>
10 min	Anatomy Now	<p>Short summary of the literature on the state of anatomical education in its current incarnation. This section will be a semi-structured lecture format relying heavily on audience participation and contribution for ideas. Members of the audience should be able to discuss this topic with ease as they will most likely be educators in the field.</p> <p>Sample discussion questions may include:</p> <p>“What is the structure of the current anatomy course being taught?”</p> <p>“What student population do you teach?”</p> <p>“What approach do you use to teaching anatomy (regional or systemic)?”</p> <p>“How many hours a week are allocated to teaching anatomy?”</p> <p>“What types of resources do you currently have available for your students? Plastic models? Cadaveric specimens? Online learning modules?”</p> <p>“Why does 3D anatomy appeal to you?”</p>

30 min	<p>3D Anatomy Demonstration & Dialogue</p> <p>Two models shown: forearm model middle/inner ear</p>	<p>Blended section on 3D anatomy. This section will combine both traditional lecture-style teaching and dynamic dialogue. Concepts will be discussed and issues will be addressed. Audience-participation is always encouraged.</p> <p>This section will begin with a demonstration of 3D anatomy (approximately 5 minutes). Two models, the middle/inner ear and the forearm, will be shown at the beginning of this segment. All members of the audience will be provided with the 3D glasses needed to view the model. This serves to display the functionality and the visual appeal of 3D anatomy. It also allows audience members who may not have viewed 3D to understand its nature.</p> <p>After the demonstration, a short lecture portion (approximately 10 minutes). Much of the material in this section will most likely be new to most audience members. As such, it should be much easier to cover this material in the given time if it proceeded through a PowerPoint format. During this section, individuals will be given one minute to write down questions or concerns that may have arisen. Topics addressed during lecture portion:</p> <ul style="list-style-type: none"> • Multimedia learning (cognitive load) • Defining 3D • Stereoscopy: What is it? <p>The topics covered in the next portion of this section lend themselves well to more audience participation. It is important to recognize that all audience members will be looking at 3D as a part of their own curriculum. Each curriculum will be different. Audience members will be encouraged to bring their own perspectives to the topics. Audience members will be allowed to brainstorm the possible answers for the following topics:</p> <ul style="list-style-type: none"> • Advantages and disadvantages of 3D anatomy • How might I incorporate this into what I am doing now?
5 min	Break	<p>Quick break to set up for the next section. Audience members are welcome to use the 3D models used during the break. Only one audience member may manipulate the model at a given time.</p>
30 min	Panel discussion period	<p>A panel of individuals with previous 3D experience</p>

	(or group discussion)	<p>will be invited and members of the audience will be encouraged to pose questions. Panel members will range from educators to students to administrators who have had experience teaching with, learning from or implementing 3D. If possible, sales reps from publishers such as Elsevier could be approached to attend and participate in the panel. By allowing audience members to write questions and concerns down on paper earlier in the seminar, it ensures that at least some questions will be asked in this section. As always, other audience members will be encouraged to answer questions to foster a more inclusive environment.</p> <p>If no panel members can be invited, an alternative group discussion may be used. Audience members can form small groups to discuss some of the positives of teaching with 3D models as well as some of the challenges they faced during implementation and usage and how they addressed them. Each group will need a moderator.</p> <p>Possible topics covered in this section:</p> <ul style="list-style-type: none"> • What are your students actually saying about 3D? • Challenges from the administrative perspective • Time frame required for model creation, hardware implementation • Difference in use for differing groups of students (health science students vs medical students vs personal trainers) • Differences in implementation for large/small classes
10 min	Conclusion & closing remarks	<p>Re-convene the audience. This would be an opportune moment to re-address issues that were not answered. Allow the audience members to speak about material that they have learned throughout the seminar. Members of the audience should also be encouraged to raise issues or voice questions that were not addressed throughout the seminar.</p>

PRESENTATION STRATEGIES

Attendees of this seminar will most likely be educators who have used or are exploring using 3D models in their curricula. Due to time limitations, the '3D Demonstration & Dialogue' section is currently highly structured. This ensures that the basics of 3D can be covered while still allowing time for dialogue. After the basics of 3D have been covered, the dialogue portion will promote audience members to brainstorm the advantages and disadvantages of 3D. By allowing the audience to contribute, it is hoped that they would begin to personalize the information and apply it to their own situation. It will make for a more meaningful conversation and reflection. The freedom of a dialogue allows the seminar to be directed to what the audience finds most interesting or helpful. However, the moderator of the discussion will have to maintain the proper course to prevent too large of a digression from the topic of 3D anatomy. It is essential to have some form of stereoscopic and non-stereoscopic interactive 3D model in order for the audience to see exactly how the models look. Break time can be extended to allow for more individuals to experience the 3D models prior to the panel discussion. Specific models were also chosen to illustrate certain benefits of 3D models. The middle/inner ear is very spatially complex and is very difficult to dissect. The forearm model was chosen specifically because of its perceived simplicity. Despite being an area that is easily dissected, using a 3D model illustrates that even 'simple' areas may have complex spatial relationships such as the path of neurovascular bundles and their proximity to landmark muscles. Through the panel discussion (or small-group discussion), the audience will have the opportunity to express their personal experiences as well as share in their own trials and tribulations with 3D models. The discussion time is essential to allow audience members to speak of their own personal situation and view 3D models in their own curricula.

Throughout the seminar, it is essential to emphasize that 3D models should not be an all-or-none solution. 3D should be integrated into current anatomy curricula and should not be used to replace current teaching modalities such as hands-on models and cadaveric dissection. Anatomical education should always be a multifaceted approach with many resources to form and reinforce knowledge.

ADDITIONAL RESOURCES

(This section contains some extra resources that might interest audience members but will not necessarily be discussed during the seminar. They cover topics such as current uses of 3D.)

Cyber-Anatomy, Inc. (n.d.). Retrieved from <http://www.cyber-anatomy.com/>

Netter's 3D Interactive Anatomy. (n.d.). Retrieved from <http://www.interactelsevier.com/netter>

Brown, P.M., Hamilton, N.M. & Denison, A.R. (2012). A novel 3D stereoscopic anatomy tutorial. *Clinical Teacher*, 9(1), 50-53.

Estevez, M.E., Lindgren, K.A. & Bergethon, P.R. (2010). A novel three-dimensional tool for teaching human neuroanatomy. *Anatomical Sciences Education*, 3: 309-317.

Hisley, K.C., Anderson, L.D., Smith, S.E., Kavic, S.M. & Tracy, J.K. (2008). Coupled physical and digital cadaver dissection followed by a visual test protocol provides insights into the nature of anatomical knowledge and its evaluation. *Anatomical Sciences Education*, 1, 27-40.

Hoffler, T.M. & Leutner, D. (2007). Instructional animation versus static pictures: a meta-analysis. *Learning and Instruction*, 17, 722-738.

Issa, N., Schuller, M., Santacaterina, S., Shapiro, M., Wang, E., Mayer, R.E. & DaRosa, D.A. (2011). Applying multimedia design principles enhances learning in medical education. *Medical Education*, 45, 818-826.

Mayer, R.E. (2008). Applying the science of learning: evidence-based principles for the design of multimedia instruction. *American Psychology*, 63(8), 760-769.

McNeill, W. (2011). Anatomy in 3D. *Journal of Bodywork and Movement Therapies*, 15, 375-379.

Ruiz, J.G., Cook, D.A. & Levinson, A.J. (2009). Computer animations in medical education: a critical literature review. *Medical Education*, 43, 838-846.

Yeung, J.C., Fung, K. & Wilson, T.D. (2010). Development of a computer-assisted cranial nerve simulation from the visible human dataset. *Anatomical Sciences Education*, 4, 92-97.