Blended Learning: An Alternative For Undergraduate Anatomy Teaching In Developing Countries

Dalynés Reyes-Colón, Gilberto Crespo-Pérez

Abstract: Anatomy, the study of tissues, organs and systems in the body, is an essential component in the curricula of many health professions. Due to curricular design, complexity of the learning material, and time devoted to teaching, anatomy learning could be compromised. Anatomy instructors and educational institutions must look for ways to complement anatomy teaching in order to better prepare students for what they will find at both, the graduate level and the work environment. In this review, we compared multiple approaches for anatomy teaching, and blended learning appears to give better results for contents comprehension, retention, and academic development.

Index Terms: e-Learning, TAM, UTAUT, Human Biology, Learning Styles

1 INTRODUCTION

Anatomy is a fundamental course in the curricula of health professions education, including medicine, dental medicine, and medical health professions, such as nursing and pharmacy, among others (Ngan et al, 2017). Moreover, at the undergraduate level, it is the very foundation of medical education and must be known in all the classes and fields of specialization (Ocak & Topal, 2015). The comprehensive knowledge of anatomy plays a vital role in proper understanding of any other discipline of Medicine (Benly, 2014). It is a subject in which students have to learn new concepts and terminologies, while recent curricular changes reduced contact hours with professors, making it even more difficult (Sawant & Rizvi, 2015). At the undergraduate level, the story is exacerbated by the absence of essential components of a complete anatomy course. In Puerto Rico (USA), possibly due to economic considerations, costs to maintain facilities, to obtain or buy materials, or by time restrictions in the course curricula, there is no college that offers Gross Anatomy courses at the undergraduate level.

- ***Dr. Dalynés Reyes-Colón*** *has a Ph.D. in Anatomy and is an Assistant Professor at the Biology Department in the University of Puerto Rico at Arecibo, Arecibo, Puerto Rico (USA). She has participated in local and international research meetings and mentored several students' associations.*
  Email: dalynes.reyes@upr.edu
- ***Gilberto Crespo-Perez****, MSCE, is currently pursuing a doctoral degree in Management Information Systems at Universidad del Turabo, Gurabo, Puerto Rico (USA). Mr. Crespo-Perez holds a Master's in Sciences degree in Computer Engineering from the University of Puerto Rico at Mayaguez, Puerto Rico (USA). He has participated as investigator in local research symposiums and investigation conferences. In addition, Mr. Crespo-Pérez is a technology blogger at www.sapientcoach.com (International Spanish & English blog).*
  Email: gcrespo27@email.suagm.edu

In these cases, the approach used to study the human body is systemically, where all the body systems are discussed separately, although correlating their functions. Sometimes, there is the opportunity to visit gross anatomy laboratories at different medical schools, but this is a limited experience, instead of a whole year laboratory work. In addition, students only study dissected bodies, but do not dissect by themselves. In some way, this systemic approach could limit students' comprehension of the human body as a whole. It is then imperative to find alternate methods to teach anatomy more effectively, in less time, and sometimes with limited resources, but without compromising education (Sawant & Rizvi, 2015). Changing the anatomy curriculum is a challenging task, and it is necessary to evaluate educational methods to determine which are the most effective and efficient (Elizondo-Omaña et al, 2004). Advances in artificial intelligence, machine learning, cloud computing, and mobile-devices are transforming the ways people are using and interacting with technology (Crespo-Perez & Ojeda-Castro, 2017). Institutions need to consider the redundant benefits that cloud, and smart device technologies can bring to their offerings. These technologies are impacting companies' and institutions' operations by changing the way they are conducting business, allowing to transform processes and, consequently, bringing innovation and efficiency. Therefore, this transformation could potentially reduce operating costs and impact organizational performance. All kind of industries can benefit from these advances, including the educational sector on developing countries. Besides the flexibility, adaptability and provisioning capabilities of cloud computing, smart-devices technologies also bring huge amount of possibilities to students on developed and developing countries. At present, institutions can offer online live and self-paced courses that can be completed from anywhere, and at any time students need. Recent technologies have been introduced that make anatomy more interesting and easier between the students and professors (Benly, 2014). However, with diverse methods and tools for teaching anatomy, the choice for the best instructional method is still debated (Jarrral & Afzal, 2016). As educators, we have identified the need to bring better, creative, and innovative ways to teach and learn. Current and new generations of undergraduate students from a variety of disciplines and curriculums, can enrich their learning experience to fulfill academic success. Due to the extensive use and demand of smart-devices by new generations

(millennials and centennials), educational institutions should consider the adoption of online learning systems and mobile applications, as complementary technologies, to attend this increasing generational demand. Considering the vertiginous growth of educational institutions adopting new technologies to their academic programs to be more appealing to the new student's generation, we reviewed related literature and identified current trends in teaching, specifically in the anatomy field at the undergraduate level. There is a diversity of technologies used for anatomy teaching. This review begins with a brief description of some methods used during traditional anatomy teaching, and is followed by some studies demonstrating how technological tools are used to complement anatomy teaching. For these technologies, we also discuss their advantages and/or disadvantages, if applicable, and propose which of them show a tendency towards better anatomy learning. The objective of this literature review is to identify current technologies that may help to overcome anatomy teaching limitations at the undergraduate level, in such a way that students obtain the necessary concepts and skills to eventually succeed in graduate schools.

2 TRADITIONAL ANATOMY TEACHING

Humans are complex organisms; so are their ways of interaction, behavior and ways to think and process information. That being said, there is not a unique and infallible way in which they acquire knowledge. The human brain's complexity and capacity to process information is amazing, and there is not a specific instructional strategy which can fully satisfy its skills, capacities and diversity. In 1983, Howard Gardner developed the *Theory of Multiple Intelligences* (Gardner, 2011), which expanded the concept of intelligence by including areas such as music, nature, spatial relationships, and personal knowledge, to the previously described mathematical and linguistic abilities (Brualdi, 1996). It is believed that everyone is born with all of them, but persons will better develop different sets of such intelligences along their development (Brualdi, 1996). That is the reason why there are multiple learning styles within one classroom (Brualdi, 1996), which require multiple teaching methods, in order to engage student to the class, and to help them to better understand the educational materials. To do that, educators need to enrich their lectures by adding audio-visual-kinesthetic experiences and multi-sensorial stimulation. Traditionally, anatomy teaching is composed of lectures and laboratory sessions that, in some ways, can benefit all learning styles.

2.1 Lectures (Chalk board or Power Point ® presentations)

Lectures are the most commonly used method for teaching and learning (Sawant & Rizvi, 2015; Benly, 2014). In this scenario, both the visual and auditory senses are the main route to absorb the information (Sawant & Rizvi, 2015). The most frequently used technology was the chalk and board. It is old, but sometimes it is essential for learning anatomy in a simple way (Benly, 2014). However, nowadays the use of PowerPoint (PPT) presentations is more popular (Sawant & Rizvi, 2015). Students can understand anatomy quickly and it will be easier to them for learning (Benly, 2014). However, although PPT's allow for better visual images, and reduces poor handwriting in students, they also reduce the interaction between teacher and students, making the class more monotonous (Sawant & Rizvi, 2015). Although, this method could be improved by using high-resolution 2D and 3D human-body structures images.

2.2 Laboratory sessions

Lectures are complemented with laboratory sessions, where students get hands-on experiences with tissues, organs and structures in the real scenario. There are several techniques used to achieve this.

2.2.1 Drawings

Drawings consist of diagrams, which help to better understand the arrangement of the components of a structure. Sometimes, physiological processes can be represented as well. Visual learners or artists are encouraged to draw anatomical diagrams of their observations during dissections, or what they learn in class, in order to recapitulate and combine concepts that will assist with long-term retention of information (Sawant & Rizvi, 2015)

2.2.2 Models

Models consist of three-dimensional representations of regions, organs or structures, presented in such a way that resembles the real anatomy of the human body. However, normally they do not present anatomical variations, and the pattern of colors may be different from those in the real body. Tactile learners are encouraged to study with models, and to prepare their own models using molding clay, since this will reinforce learning and help them develop a real three-dimensional image of structures and their relationship (Sawant & Rizvi, 2015).

2.2.3 Human cadavers dissections

In medical schools, anatomy teaching is based on the use of human cadavers (Sawant & Rizvi, 2015). This practice allows to better understand the three-dimensional anatomy, to appreciate anatomical variability amongst persons, and for the students to be more comfortable for learning anatomy (Sawant & Rizvi, 2015; Benly, 2014). In addition, it gives dissecting manual dexterity, and helps to develop proper attitudes toward future patients (Kraszpulska et al, 2013). Although maintaining a dissecting room is very costly (Benly, 2014), studies demonstrate the benefits of such investment. In 2013, Kraszpulska and coworkers conducted a study with dental and medical students, where data showed that 98% of dental students and 95% of medical students found cadaver dissection beneficial, since it allowed better visualization of structures, increased spatial learning, and permitted to see variabilities amongst real human bodies. In the same study, the majority of students disagreed with the idea of complete replacement of cadaver dissection by computer-based programs (Kraszpulska et al, 2013). In 2015, McGarvey and collaborators conducted a different study to compare the effects and impact of the exposure of nursing students to an anatomy room for anatomy teaching, with the effects for students taught anatomy in a laboratory using anatomical models. Their findings suggest that learning anatomy using cadavers, although increases anxiety levels in students, is a beneficial learning experience, and could also be a valuable way to encounter death for the first time in a protected environment, rather than in a clinical setting (McGarvey et al, 2015).

2.2.4 Plastination

Cadavers are fixed in hazardous chemicals and are expensive to maintain and properly being disposed of, which may be some of the reasons why some schools substituted dissection with plastinated specimens (Sawant & Rizvi, 2015). Plastination is a technique created by Gunther von Hagens in the seventies, in order to conserve cadavers, prosections and slices in a safe, strong, and durable polymer medium that is odorless and inert (Sawant & Rizvi, 2015). These plastinated specimens allow students to learn anatomical structures, without compromising accuracy, even though they are dry (Sawant & Rizvi, 2015). However, these specimens are also expensive and not every school can afford to have a whole plastinated body.

2.2.5 Imaging

Medical imaging technologies are also used in order to study, not only normal, but also pathological anatomy (Sawant & Rizvi, 2015). It is common practice to give students different medical images to study and review some structures of the human body. However, different kind of images give different perspectives on a particular structure. For example, radiographs allow students to study primarily skeletal anatomy, while ultrasound images allow students to visualize living soft tissues and organs, which can be correlated with cadaveric dissection (Sawant & Rizvi, 2015). On the other hand, computerized tomography (CT) scans and magnetic resonance imaging (MRI) help specifically in the study of sectional anatomy, by transforming three-dimensional organs and structures into two-dimensional format (Sawant & Rizvi, 2015).

3 NEWER TECHNOLOGIES FOR ANATOMY TEACHING

Online learning management systems, cloud computing and smart-devices are changing the way new generation of students are interacting with learning material and acquiring knowledge, by combining face-to face and remote course delivery at any time, everywhere (El-Masri & Tarhini, 2017). More recently, technological instruments (online academic platforms, online learning systems, mobile applications, 3D printing, and virtual reality among others) have been also included in the anatomy course, in order to give students different perspectives on previously studied material. Teaching rooms can be equipped with these newer technologies, in an effort to engage students with different learning styles, to allow them to be immersed into a virtual world inside the human body, stimulating and activating their multi-sensory capabilities, and expanding their learning experience. Behavioral, technology and organization theoretical frameworks can help academic institutions and researchers to better understand the factors that lead to the adoption of technology in their curricula and programs. Among these frameworks is the *Technology Acceptance Model* (TAM), developed by Fred Davis (1986/1989), which explains that the perceived usefulness and ease of use, determine an individual's behavioral intention to use a system (El-Masri, & Tarhini, 2017; Lin, Persada, & Nadlifatin, 2014; Liaw, 2008). There is also the *Technology Organization-Environment* framework (TOE), which explains from an organizational, technological and environmental perspectives (DePietro, Wiarda, & Fleischer, 1990), the likelihood of adopting a technology by an institution. Similarly, *The Unified Theory of Acceptance and Use of Technology* (UTAUT), proposed by Venkatesh et al (2003; 2012), consists of seven key constructs (first were performance expectancy, effort expectancy, social influence, and facilitating conditions; then price value, hedonic motivation and habit were added) together with four moderating variables (gender, age, experience, and voluntariness). All these have been used by researchers to predict behavioral intention to use technology in organizational contexts.

3.1 Social media (YouTube, Facebook, Twitter)

In 2016, Barry and collaborators conducted a survey, with second year undergraduate medical and radiation therapy students, regarding their use of online social media for their anatomy learning. They found that the majority of the surveyed students employed web-based platforms to look for information, mainly YouTube as their primary source of anatomy-related video clips. Their study suggests that the academic anatomy community may find value in the integration of social media into blended learning approaches in anatomy programs, since it can empower interaction with students outside scheduled contact hours, particularly if the platform is already in use by them (Barry et al., 2016). They also found that YouTube, Facebook, and Twitter stand out as having enormous potential, particularly if they are provided with context through academic oversight (Barry et al., 2016). The authors suggest that a change in anatomy instructor's perceptions may be needed regarding the use of social media, given that a significant portion of students consult online resources, rather than ask the educator to answer a question (Barry et al., 2016).

3.2 Mobile Devices (Tablets and Smart Phones)

Since there are not many studies that evidence the impact of using neuroanatomy apps on a mobile device on student's perception of learning in practical settings and on learning outcomes, in 2016, Morris and coworkers did a research to evaluate it. It was done with a number of student cohorts from 2011-2013. Their results showed that students who made an extensive use of preconfigured tablet devices, considered the devices to be beneficial for learning and found them easy to use (Morris et al, 2016). They found a tendency for students to use tablets for information retrieval and conceptual understanding, but not so much as to record information in written, nor audio form, despite having an application to do just that (Morris et al., 2016). They suggest that anatomy and physiology educators should integrate mobile learning opportunities into the curriculum in order to enhance students' perception of their learning and enjoyment within classes, with minimal support and training (Morris et al., 2016). This study supports the theoretical framework of *technology acceptance* (TAM), which demonstrates that several factors influence users' acceptance of technology, including perceived ease of use, perceived usefulness, behavioral intention, effort expectancy, and social influences. It also showed that understanding of neuroanatomy improved as a result of the introduction of a blended learning approach to the practical class (Morris et al., 2016).

3.3 Computer-assisted instruction (CAI)/Computer assisted-learning (CAL)

Learning Management Systems (LMS) and Online Educational Platforms (e.g., BlackBoard Learn, Moodle, Edu20, MyLab & Mastering, among others) have been constantly studied by

researchers (El-Masri, & Tarhini, 2017; Lin, Persada, & Nadlifatin, 2014; Liaw, 2008), in order to validate their benefits on improving students learning. In the majority of cases, these platforms work under the cloud computing concept, where the institutions are able to offer their lectures through the web. Some institutions are even offering entire curriculums through the software-as-a-service (SaaS) model, where students only need an internet browser and a network connection (preferable with high bandwidth), allowing them to take classes all over the world, with the flexibility of being highly available 24/7/365, and overcoming barriers that traditional education (in the classroom) represents. However, this teaching method may not necessarily cover all educational discipline requirements or exposure needed, due to class complexity. Such is the case of teaching anatomy, where students are required to have hands-on experiences that will allow them to be exposed to what they will really experience outside of classrooms. In 2004, Elizondo-Omaña and collaborators conducted a study where they compared final grades of students who used the traditional method, with those students who used the traditional method supported by computer-assisted learning (CAL) for both, the Anatomy and Neuroanatomy courses. In overall, they found that the modified traditional method supported with CAL was the best option, since students had higher final grades for both courses (Elizondo-Omaña et al, 2004). In a different study, Pereira et al (2007) aimed to implement blended learning strategies in the teaching of human anatomy. Their goal was to analyze both, the impact of such strategies on academic performance and the degree of user satisfaction. They conducted the study with first year students of the Biology degree curriculum, and found that the percentage pass rate was higher in the blended-learning group, when compared with the traditional teaching group. However, there were no differences between the groups regarding overall satisfaction with the teaching received. With these results, they concluded that blended learning helped to enhance knowledge acquisition and retention (Pereira et al, 2007). In 2013, Means and coworkers conducted a meta-analysis to compare the effectiveness of face-to-face, blended, and online learning. Their findings suggest that pure online learning is equivalent to face-to-face instruction in terms of effectiveness, while a blended approach is more effective than instruction offered entirely in face-to-face mode (Means et al, 2013). With their observations they concluded that blended learning tends to require additional learning time from students, as well as more instructional resources and course elements from the professors, to encourage interactions among learners; opening the possibility that these variables also contributed to the positive outcomes for blended learning (Means et al., 2013). With the paradigm shift of teaching towards student-centered approach, Jarrral and Afzal (2016) also wanted to evaluate students' perspective on the various teaching-learning strategies used in their medical schools. They conducted a survey among first and second year students, at the end of their anatomy course. They concluded that undergraduate students preferred to be brainstormed about the topic of study by a demonstrative class with audiovisual help, followed by a self-study time from textbooks or web sources, and finalizing with hands-on dissection or prosection, in order to get better knowledge and understanding of the subject (Jarrral & Afzal, 2016). As recently as in 2017, Losco and collaborators produced a review article aimed at identifying methods used to teach anatomy, including those demonstrated to enhance knowledge acquisition and retention. They found a wide variety of teaching interventions represented in the range of studies. Computer-assisted instruction (CAI)/computer-assisted learning (CAL) studies predominated in terms of teaching interventions, followed by simulations (videos or demonstrations) and models (prossections and clay modeling), among others. In addition, CAI/CAL and simulation studies demonstrated better results when compared to traditional teaching methods, supporting the notion that it can be used as a partial replacement for dissection, or as a valuable tool in conjunction with dissection (Losco et al, 2017). They concluded that combining a variety of teaching methods or multimodal teaching and emerging technologies in the teaching of anatomy could be beneficial for learning and retention (Losco et al, 2017). Also in 2017, Tam and collaborators performed a literature review to assess the use of CAL in undergraduate medical student anatomy education. They analyzed eight quantitative studies, and found that although CAL can improve learning, there is not enough evidence to support that these resources have a true place for replacing traditional methods in anatomy teaching. They suggest more research to determine how to use CAL in conjunction with traditional teaching methods, or how it can be integrated into the current anatomy curriculum. However, they also state that CAL is a possible option for teaching anatomy (Tam et al, 2017).

4 Discussion

Although anatomy concepts remain relatively constant, modes to present the information have proliferated in recent decades. Technology will likely bring new changes in the teaching process, even though the presence of the teacher in the room will still be necessary to achieve interactive courses (Tanasi et al, 2014). However, even with all these methodologies, Anatomy is a highly demanding discipline. This is why proper utilization of newer technologies, combined with traditional teaching methods, will lead to enhanced understanding of gross anatomy and improve students' performance (Sawant & Rizvi, 2015). On the other hand, educational institutions adopting new and state-of-the-art technologies should consider the potential benefits that these adoptions can provide for attracting new student generations and enhancing their potential for successful outcomes.

5 Implications

Studies on teaching methodologies will help educational institutions to better understand which are the most influential factors that lead to a holistically implementation and utilization of computer assisted learning systems. It will also serve as an implementation guide when planning new technological strategies and adoption initiatives. Blended learning combines multiple delivery media that are mutually complemented and promote both learning and application-learned behavior (Singh, 2003). It may include a mix of traditional instructor-led training, synchronous online conferencing, self-paced study, and structured on-the-job training from a mentor (Singh, 2003). Research on this will help to establish theoretical models to evaluate factors that most influence the implementation of an online computer assisted learning system. It will help to confirm whether theoretical models are sustained or rejected, as well as to test and expand the

TAM/TOE/UTAUT in order to identify predicting, controlling and moderating variables.

6 Conclusion & Future Research

Since there is a body of evidence suggesting that proper utilization of newer technologies, along with traditional teaching methods, may lead to better understanding of anatomy and may improve students' performance (Benly, 2014), it would be interesting to conduct study cases at institutions in underdeveloped or developing countries, to evaluate if a blended teaching approach is more convenient to overcome curricular limitations. If such studies prove or show a tendency that a blended teaching approach is a better alternative, academic institutions should consider including it as an essential and mandatory part of anatomy curricula.

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