

A mixed reality technology as a supplemental learning tool of the cardiovascular system

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Abstract—Learning anatomy and physiology is a difficult task for students entering the field of Health Sciences and Medicine. While cadavers and textbooks are the current standard for teaching anatomy, potential alternative is the utilization of mixed reality technologies. These technologies have the ability to augment human anatomy models directly onto the user, who can then interact with them in a 3D environment. Our proposed technology, known as the Magic Mirror, was assessed in the Anatomy and Physiology I lecture at the University of Ottawa. Data from surveys was collected based on a five-point Likert Scale. Surveys focused on student interaction with the Magic Mirror technology as well as their thoughts about how it compared to learning the cardiovascular system versus traditional Atlas textbooks. Final results demonstrated a strong positive assessment of the Magic Mirror which offers the potential to continue improving the technology for future implementation in anatomy curricula.

Keywords—Augmented Reality, Virtual Reality, Anatomy Learning, Cardiovascular System

I. INTRODUCTION

Knowledge of human anatomy is essential when entering into a field such as Health Sciences or Medicine. The most common way of teaching students is through the use of Atlas textbooks and cadavers. Atlas textbooks provide detailed labelled pictures of anatomical structures and systems, but are unrealistic compared to what would be seen during cadaver dissections because of their two-dimensional format [1]. Another benefit to cadavers over Atlas textbooks is the potential to find pathological conditions or abnormalities when carrying out dissections [1]. Unfortunately, cadavers are a finite resource and expensive to maintain. There are also some cultural practices that prohibit cadaver dissection [2], making it difficult for some students worldwide.

Our proposed solution is to utilize newer technologies as an option for students' anatomy learning, more specifically the combination and utilization of augmented reality (AR) and virtual reality (VR). A previous study compared AR, VR, and tablet-based software as tools for teaching anatomy

[3]. This study found that AR and VR were both engaging and immersive which increased the motivation for students interacting with them. By making the learning experience more enjoyable, students are more likely to feel motivated to use the tool to study anatomy. Other works found similar student responses to AR and VR systems that displayed radiological slices of the human anatomy or muscle models [4-7]. By having a more interactive system, student-centric learning is promoted, providing further motivation to anatomy learning. Another benefit to interactions with these technologies is an increased three-dimensional understanding due to repeated use.

The aim of our study was to evaluate a Magic Mirror (MM) technology within anatomy courses at The University of Ottawa. We focused on the learning of the cardiovascular systems and performed a qualitative assessment on student learning when comparing the MM to traditional Atlas textbooks. The research outcomes provide a basis for investigating innovative technologies and their potential in facilitating student learning.

II. METHODS

A. The Magic Mirror

The MM is a mixed reality system that allows the overlay of anatomical data onto the user. The program displays an augmented view onto the user on half the screen while offering a virtual view of the augmented data on the other half of the display (Fig. 1). This is done by using a Red-Green-Blue-Depth (RGBD) sensor to track the user interacting with the system in real-time, while simultaneously displaying the data onto the screen. The user is able to look and interact with different organ systems such as the cardiovascular system in a three dimensional space. They have free control over the angle in which they view the system, and can toggle anatomical labels on and off to assist them in learning human anatomy. This technology is targeted for university-level students and professors as a supplemental tool to help in the learning and teaching of human anatomy.



Fig. 1 Screenshot of the Magic Mirror during cardiovascular system learning.

B. Recruitment

We obtained Ethics approval through the Research Ethics Board at the University of Ottawa. A total of 18 undergraduate students participated in a pilot study. They were enrolled in the Anatomy and Physiology I course (French language delivery) during the Fall 2018 semester. Each participant interacted with the Magic Mirror during a 15 minute session, then completed a survey giving their opinions on the technology and how it compared to learning from a traditional Atlas textbook.

During the interaction period, participants were guided by an undergraduate student trained by an anatomy professor through a 15 minute lesson of the cardiovascular system. The lesson covered the location of major arteries and veins in the cardiovascular system throughout the human body.

C. Surveys

At the conclusion of the interaction phase, all participants filled out an anonymous survey featuring six statements about the technology as well as an empty space where they can provide suggestions on improvements they want to see added to the Magic Mirror technology (Fig. 2). The six statements were assessed based on a five point Likert Scale with the following options: “1/strongly disagree”, “2/disagree”, “3/no opinion”, “4/agree”, and “5/strongly agree”.

The Magic Mirror is...	←strongly disagree					strongly agree→
(1) increases motivation to learn anatomy	<input type="radio"/>					
(2) stimulates active learning	<input type="radio"/>					
(3) helps with 3-D learning	<input type="radio"/>					
(4) offers benefits compared to textbooks	<input type="radio"/>					
(5) is a more engaging introduction to anatomy	<input type="radio"/>					
What do you like about the Magic Mirror System/what would you like improved?						
Final grade I give the Magic Mirror	A	B	C	D	E	
(6) I think the exercise compliments textbooks when learning anatomy	<input type="radio"/>					

Fig. 2 Survey provided to student participants.

III. RESULTS

Table 1. Descriptive statistics of 5 point Likert scale survey

The Magic Mirror...	Mean	Standard deviation
(1) increases motivation to learn anatomy	4.4	± 0.73
(2) stimulates active learning	4.3	± 0.75
(3) helps with 3D learning	4.5	± 0.71
(4) offers benefits compared to textbooks	4.2	± 0.81
(5) is a more engaging introduction to anatomy	4.3	± 0.71
(6) compliments the use of textbooks when learning anatomy	4.3	± 1.14

In this section, we provide an analysis of the results obtained from the student surveys. Figure 3 and Table 1 show the data obtained from the participants with the mean scores and standard deviation for each of the statements based on a five point Likert Scale. A mean closer to 1 indicates strong disagreement, while a mean closer to 5 indicates strong agreement with the statement.

Each statement had a mean score above 4 with a standard deviation of approximately 1. This means that almost all participants agreed with each statement on the survey. We believe this shows the confidence the participants have in the MM as a supplemental tool for anatomy learning.

Overall, the participants had a strong positive reception to the MM. The statement with the widest range of answers was the idea that the MM could compliment Atlas textbooks as a tool for learning anatomy (SD = 1.13). It was perceived that one of the main benefits of the MM to students was the ability to view the model in a 3D environment directly onto their bodies.

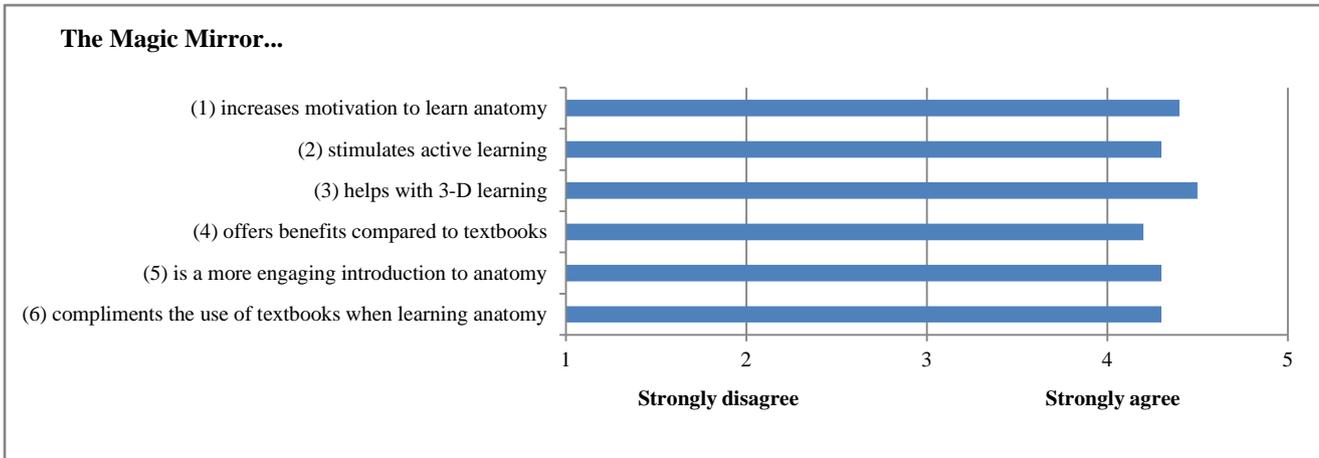


Fig. 3. Results for a 5 point Likert scale

IV. DISCUSSION

Our results demonstrated that students who participated were more motivated to study anatomy when using the MM. It is a tool that allows students to actively learn while also allowing them to utilize previous knowledge that was obtained in a lecture or from reading an Atlas textbook. The students also believed the MM has the potential to be comparable to Atlas textbooks as an anatomy teaching tool. We can also see that it is more engaging than strictly learning from a textbook while also providing benefits that cannot be obtained from only reading about human anatomy. There is also general agreement that textbooks and the MM can be used with one another to ease the learning process of human anatomy. In the future, we will carry out a similar study with professors who teach anatomy and physiology courses to obtain a “needs assessment” of the MM prior to their considering using it in their courses.

V. CONCLUSION

In this paper, we presented the results of a survey asking students in an anatomy and physiology course what their opinions were on a mixed reality Magic Mirror technology after they interacted with it during cardiovascular system learning. The technology allowed students to take a more active role while also allowing them to practice what they were taught in their anatomy lectures. Final results were encouraging and we will continue to develop and assess the MM so that it can one day be integrated into the anatomy curricula.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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