Augmented Reality in Biophysics 5.0 through Assemblr Studio

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***Abstract*—Augmented reality is the lowest-cost immersive methodology available today, allowing users to enter the metaverse with boundaries defined only by their imagination. We have been implementing augmented reality in our biophysics discipline for several semesters, observing a significant increase in student commitment and participation. This methodology has dynamically transformed our classes, benefiting not only students in the health field but also those from diverse academic backgrounds. In this paper, we detail our experience with augmented reality, focusing on how it has enhanced the educational experience. By utilizing the Assemblr app, we have been able to capture students' interest more effectively, making the learning process in this complex subject more engaging and interactive. The app allows us to create immersive 3D models and interactive content that students can explore, providing a hands-on learning experience that traditional methods cannot offer. Our findings suggest that augmented reality not only increases student engagement but also facilitates a deeper understanding of biophysics concepts. This innovative approach has the potential to revolutionize the way we teach complex subjects, making learning more accessible and enjoyable for all students, regardless of their academic focus.**

***Keywords*—metaverse, biophysics, Education 5.0, augmented reality**

I. Introduction

The physical reality we currently live in is intertwined with virtual reality, giving rise to the metaverse term, commonly referred to as immersive methodology, and should not be confused with mixed reality, which involves the combination of virtual and augmented reality [1]. Nowadays, this methodology has been increasingly used, but still with restrictions, primarily due to the high cost associated with virtual reality. However, this issue is mitigated when working with augmented reality [2].

In reality, experiencing a world of possibilities, or being in financially inaccessible locations, has always been a human desire. In this regard, being able to study the human body, grope it, interact with it, and awaken sensations, is a scenario that can become real, being our limit only our imagination.

Before delving into this topic, it is important to differentiate and clarify the reason for the choice of Biophysics and other related health areas classes.

A. Biophysics

Biophysics studies the interrelation among matter, energy, space, and time in biological systems. However, in recent years, we have witnessed the fading away enthusiasm for this interdisciplinary discipline, due to its high complexity.

In this context, we are actively committed to the Education 5.0 application, meaning that we are incorporating various educational technologies at our disposal. In this regard, we have chosen augmented reality, for its lower cost and enhanced visualization of concepts.

B. Benefits

The importance of using augmented reality in biophysics arises from a variety of reasons, such as: (i) this often involves abstract concepts and microscopic processes that are challenging to visualize. Augmented reality enables the creation of interactive 3D models, making these concepts more tangible and easier to comprehend; (ii) augmented reality allows students to apply biophysical concepts in simulated practical contexts. This facilitates understanding of how these concepts apply in the real world, promoting more meaningful learning; (iii) in addition, we can make classes more dynamic and interactive. This breaks the monotony of traditional lectures and encourages active student participation.

An alternative would be for teachers to provide their students with opportunities to be in locations aimed at expanding the classroom discussion, such as museums, virtual laboratories, and, our main focus, experiencing the human body up close. In other words, they would be able to enter the body, see its intricacies, address their doubts, touch, and amidst this immersion, visualize, manipulate, and interact with complex data. Consider, for example, being in the Louvre, in Paris, during a visitation.

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In this work, we will present how we apply augmented reality in biophysics classes, and through this process, we have experienced increased student motivation, coupled with a dynamization of classes, which has led to greater student participation, turning them into active participants in the teaching and learning process.

II. Literature Review

A. Virtual Reality (VR)

Science should be presented as a set of specific competencies that enable the understanding and management of natural and technological phenomena, present both in everyday life and the comprehension of the distant universe, based on the principles, laws, and models it constructs. In this context, multimedia acts as a necessary bridge to ensure the competencies required by the National Curriculum Parameters are implemented [3, 4]. Within this discussion, one can consider the use of multimedia to facilitate the learning of individuals with special needs. Information and communication technologies [5] offer this social segment the possibility of overcoming the limitations imposed by their physiological condition.

We can affirm that those involved believe in what they are touching, and intertwined with the audio, they are invited to leave the physical reality and enter virtual reality [6]. In the educational context, the application of virtual reality in classes makes them more interactive, renders learning immersive, and adds to students' knowledge. Subsequently, we observe increased commitment in the classroom, making it an extremely motivating and inclusive lesson.

In the classroom, the student tackles a real problem in an unreal environment, using simulators and virtual reality goggles, etc., as shown in Fig. 1.

Fig. 1. Virtual reality goggles used by student.

The great advantage of this methodology lies in working collaboratively and enjoyably, as having something attractive and pleasing creates memorable moments. Through this memorization, we will transfer information in the chosen discipline.

Additionally, when applying immersive methodology, the student has contact with more effective learning, gains in educational performance, and is assessed in real time, without the normal pressure of a traditional evaluation process.

Despite being aware of this myriad of advantages, we only have a single virtual reality headset, leading us to the thought that the high cost of working in this way is a disadvantage.

For instance, for a class of 45 students, the ideal would be to have 45 headsets, and so forth, despite having the possibility of creating our own with readily available materials [7].

B. Augmented Reality (AR)

To overcome the aforementioned disadvantage, it is essential for us to work in augmented reality. Instead of transporting to a virtual world (where you capture digital images and reproduce them in the real world), augmented reality is based on the material environment and combines it with virtual elements, easily accessible by using only each student's smartphone.

In augmented reality, we have a "mix" of real and virtual objects, and through our senses, we can overlay real and virtual objects. Augmented reality is a technology that enhances the real world by overlaying digital information on it. Additionally, we can project images and record them, allowing for real-time experiments without any additional cost.

Among the range of advantages of working with this type of methodology, we can highlight that augmented reality immersion occurs in the real world. Furthermore, it provides an enhanced user experience, where augmented reality offers a more engaging and immersive experience, ensuring that users interact with digital objects in the real world, improving user experience, making it more interactive and enjoyable.

Augmented reality presents greater efficiency, as this educational tool can be used to improve the efficiency of various tasks, such as training and "retraining", with a differentiated learning approach. It provides an interactive educational content that engages students and makes learning more fun and effective. This can be particularly useful for teaching complex subjects or providing practical training, as in the case of Biophysics.

C. Biophysics 5.0

Biophysics studies the relationship between the fundamental components of the universe (matter, energy, space, and time) in biological systems. However, the way it has been taught, in recent years, has become increasingly tedious. Regarding, revitalizing this discipline, by leveraging Education 5.0, is crucial.

Through Education 5.0, we can define the most significant quantities in Biological Sciences and Physics and discuss them confidently, applying immersive methodologies and suitable educational tools.

Augmented Reality (AR) has several applications in Biophysics, such as: (i) visualization of biological processes where we can create interactive 3D models of biological processes, allowing users to explore and better understand these processes or even create interactive models of cells, proteins, or molecules, that can be

manipulated in real-time; (ii) monitoring physiological signals where there is the possibility of monitoring physiological signals, such as heart rate or blood pressure, in real-time, as seen in biomedicine applications and clinical situations, for monitoring vital signs; (iii) training in diagnostic techniques: by creating interactive simulators that allow students to practice diagnostic techniques, such as reading X-rays or performing ultrasounds; (iv) studying complex biological systems, such as the brain, by creating interactive models that allow researchers to investigate the relationship between the structure and function of these systems; (v) molecular identification, such as proteins or antibodies, in real-time, allowing researchers to visualize the distribution of these molecules in tissues or biological samples.

To study this range of applications, we began with Mozaic 3D free app, widely used during remote periods in both synchronous and asynchronous settings, as shown in Fig. 2.

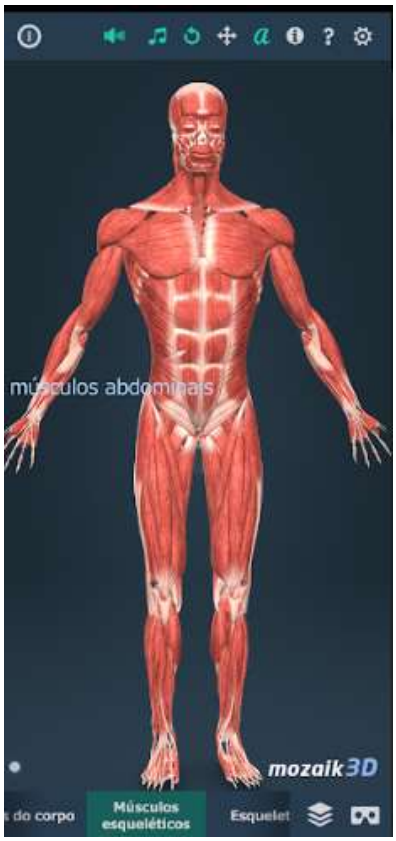

Fig. 2. Mozaic 3D mediated class.

Through this application, the student can explore every part of the human body. In a 3D view, he can study skeletal muscles and the biophysics of systems such as blood circulation, respiration, renal function, vision, and hearing.

In this regard, we initiated our actions by applying Education 5.0 in this discipline, taught in both Physics and Biological Sciences courses, naming it Biophysics 5.0.

The use of Education 5.0 is an ideal choice to renew the discipline because student becomes the protagonist of the content and works, collaboratively, with their peers. The student seeks solutions that involve innovation and a maker approach. During this process, soft skills such as communication, proactivity, teamwork, etc., are developed, and an increase in productivity and enjoyment of study becomes evident.

Among the possible avenues, we are at the forefront, in the application of Assemblr app, in our classes.

III. Materials and Methods

Assemblr is a platform that enables you to create interactive, collaborative, and fun learning activities in 3D and augmented reality [8], Fig. 3.

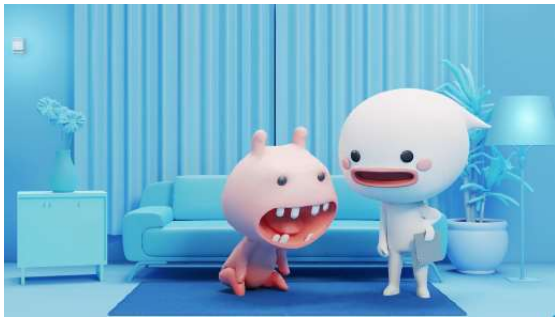

Fig. 3. Assemblr platform.

This app can be downloaded from the Play Store for free, offering free monthly and annual plans, and can be accessed through website (platform) or smartphone app.

The platform is used by teachers, students, designers, marketing professionals, and content creators worldwide to create AR experiences in various sectors, including education, entertainment, retail, advertising, and more.

The mobile app allows users to create 3D models and AR experiences without any programming knowledge. With an extensive library of 3D assets, users can easily drag and drop objects, to create their own virtual reality scenes.

This tool provides a platform for users to share and explore AR experiences created by others, making it a community-oriented app, for creativity and innovation.

On the platform, the teacher creates his library, and as an example, we present in Fig. 4, a model used in biophysics classes on blood circulation.

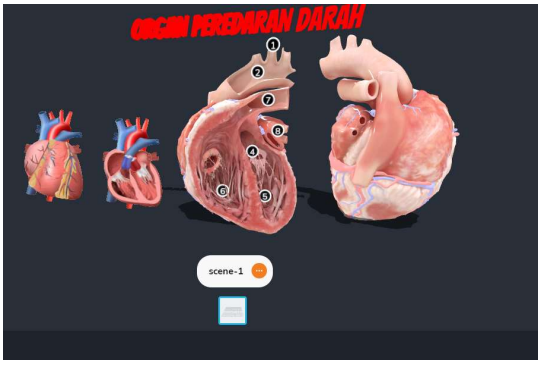

Fig. 4. Biophysics of blood circulation.

In the case of Fig. 4, we only used a single scene, which, by clicking on items 1, 2, 3, 4, 5, 6, 7, and 8, shares knowledge of each part of the human heart. The side figures present other views of the heart. In this created Assemblr, we mention the function of material and energy

communicator that circulatory system possesses. With this tool, the student is invited to observe that, the system consists of a heart acting as a "pump", blood vessels forming a continuous network throughout the body, blood acting as a fluid, and we mention the control system connected to the central nervous system.

During the class, the teacher may share the Quick Response Code (QR CODE) with the class, which, can be read, directly by cell phone after students download the app for free, thereby acquiring the lesson prepared by their teacher. It's worth pointing out that you can create as many scenes as you want, as shown in Fig. 5.

Fig. 5. QR CODE visualizer.

If the teacher does not have the option to print the QR CODE, he can use other sharing methods allowed by the platform, as shown in Fig. 6.

Fig. 6. Modes of sharing.

Another possibility is to include explanations directly in the scenes, as shown in Fig. 7. In this format, the teacher can choose to add explanations directly in the text or create an avatar with audio, making the lesson inclusive.

Assemblr allows users to enjoy a template for free or edit some of them, if they fill in the fields indicating their interest on the platform and their learning category, up to that point.

IV. Result and Discussion

We use the educational tool as a supplement to our classes, allowing students to expand their post-lesson studies, based on their level of interest.

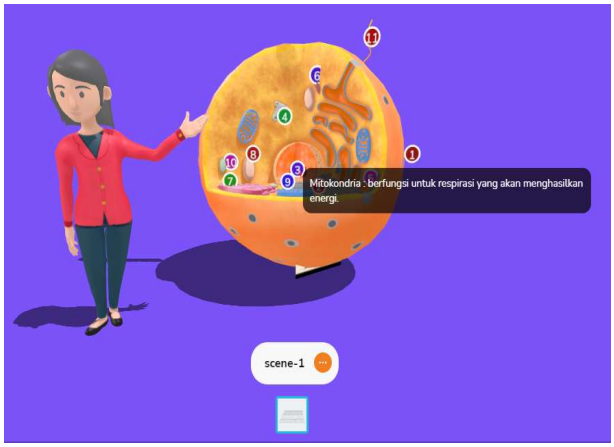

Fig. 7. Lessons of cells.

Facilitating teaching-learning process should be a constant pursuit for educators who work with and advocate for Education 5.0. Making a complex subject more approachable for both, teachers and students, is crucial in this process. In recent semesters, we have been focused on making the content more interesting and engaging, which has resulted in improved academic performance by students. Currently, we are expanding the application of the platform to other disciplines, and in Fig. 8, we present our cover library [9].

Fig. 8. Biophysics 5.0 course.

Fig. 9 presents the approval rate, in recent years, in our discipline (data taken from our institution's academic system). The increase is evident, as the semesters progress.

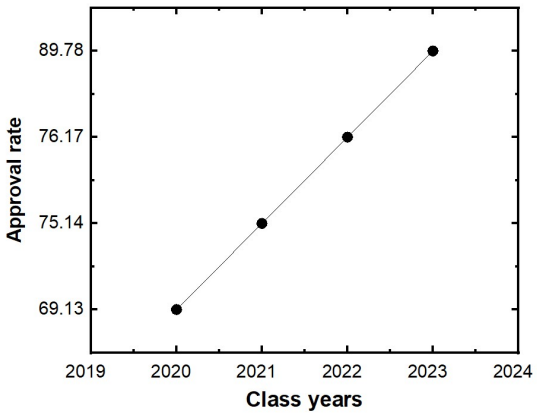

Fig. 9. Class years as a function of approval rate.

V. Conclusion

Augmented reality is an exciting technology that has the potential to transform how we interact with the world around us, being easily accessible, when considering that students, regardless social class, own smartphones.

We have been able to demonstrate how to transform a discipline, considered complex, through the Assemblr Studio platform, making it enjoyable. Through this methodology use, it is possible to create interactive and immersive experiences, that enhance user involvement and the efficiency of various tasks. Additionally, it can be used to improve education and enlarge the level of commitment of those involved.

With the use of this platform, each student can learn at his/her own pace, respecting the pre-class, class, and post-class triad, and we can observe the search for new platforms and shared apps in the classroom.

By applying immersive methodology, we can collaboratively work, adopting the maker approach, developing soft skills, including social skills, teamwork, and proactivity.

Finally, augmented reality has the potential to be a powerful tool to help understand and study biological processes, allowing for better visualization and interaction with complex biological systems. As a future work, we intend to create models, in our library, capable of performing evaluative activities, and provide real-time feedback.

Conflict of Interest

The authors declare no conflicts of interest.

Author Contribution

All authors discussed the results and contributed to the final manuscript. In particular, Welberth S. Ferreira conducted the research; Rafaella C. Souza and Luciano C. Rios analyzed the data and plotted the graphs; Suelen R. B. Ferreira wrote the final version of the paper; all authors had approved the final version.

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