The Use of Augmented Reality as a Tool in Human Anatomy Classes

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Abstract- **Recently, there has been a major increase in the use of Augmented Reality (AR). Some hybrid teaching methodologies use different technological resources to improve teaching/learning programs. This research aims to assist such programs that involve human anatomy classes by providing an extended use of AR with the help of several tools, such as wireless networks, smartphones, computers, and other devices. Our goal is to simplify and further deepen the learning experience for human anatomy students in undergraduate health care courses. To achieve its goal, the research intends to produce a smartphone app and apply it to the target audience.**

Keywords- information technology; hybrid teaching; augmented reality; human anatomy; telematics.

I. INTRODUCTION

Teaching has always been fundamental to our culture as human beings. Because it has constantly evolved, constant improvement is also necessary.

Healthcare professionals are essential to society and thus well-trained professionals are vital for improving services provided to the population. This relevance has inspired us to contribute to their professional education.

In this context, virtual reality can be useful and Cardoso [9] affirms that virtual reality has the potential to provide an education as a process of exploration, discovery, observation and construction of a new vision of knowledge, offering the apprentice an opportunity to better understand the object of study.

The idea came after classes in the postgraduate course in Telematics offered at the Federal Institute of Education, Science and Technology - IFTO campus Palmas, located in the municipality of Palmas in the state of Tocantins, Brazil. This research aims to contribute to teaching and learning experiences with content related to human anatomy. The target audience are students from different institutions who are learning such content.

Tools such as computers, smartphones, and the Internet, are already used together for to purpose of teaching and learning. They are also used in anatomy classes, but generally at a high cost both for the educational institution and for the student, creating an economical obstacle to academic performance. Aiming to reduce such costs and offer a tool that accelerates and facilitates the process of teaching and learning, we intend to develop an app (application) for smartphones with human anatomy contents, presented in three-dimensional image format. In order to improve the users' experience and visualization of the images, our idea is to insert augmented reality technology to bring the user closer to the actual visualization of the object portrayed.

AR provides a view of reality by combining real-world elements with elements of the virtual world that are created in three dimensions in real time. The insertion of this technology applied to the teaching of anatomy can contribute to a more dynamic class and a more interesting presentation of the contents and so facilitate learning.

The app being developed was named Augmented Reality Applied to Medical Study - RAMED and is in production; it is currently in the prototyping phase and a first test has already been done in order to map the user experience. Resources from the LAB MATICA Tocantins laboratory and from the AppSheet were used to construct the RAMED prototype.

The rest of the document is structured as follows: Section II lists current examples of mobile apps applied to education; Section III explains the goals of this research and describes the materials used in construction of the app prototype; Section IV presents the results of the first customer survey; Section V presents the potential of this project and indicates its potential future uses.

II. RELATED WORKS

Google AppSheet tools are frequently used to facilitate database development and operation. In this paper, we are going to present some activities that have used this tool for facility development solution involving a database and cellular applications.

Mobile devices play a fundamental role in spreading information.

Manoel [2] affirms that cell phones and tablets are more common than television sets nowadays and that there are, on average, 4 mobile devices per person in a middle-class family.

Moreira [4] presents a solution to assist the mathematics teaching at the elementary school level by using a cellular app with augmented reality. According to the author, the use of this app in his classes, aided by the fact that all his students possess a cellular device, made the classes more attractive since everyone focused more on the exercises, knowing that the answers would be provided by cell phones and ranked as if in a game.

Magalhães et al. [1] also presented the use of a mobile app, created using an Open Source tool, to assist music

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teaching in high school classes. The authors demonstrably improved students' results using, in the classes, the application developed and with subjective evaluations provided by students. Additionally, Santos [5], shows that the use of a mobile app can help safeguard environmental preservation areas. For this purpose, they developed an app that generates a kind of social network where anyone can check whether there is any generating fact, spontaneous or caused by humans, that is compromising rivers, forests, etc. The app can take photos of the event and send them to the network in real time, including the location, so that public agents can reach the place.

Mobile apps have also been used to improve administrative procedures. Martins [3] proposed that, with a cell phone, teachers of the municipal school system of Palmas, in Tocantins can have access to the results of the national "Brazil Test", a objective test for measuring the knowledge of students in the elementary school.

The indicators provide important information for teachers to work with their students during the school year with methodological innovations. Without the use of the app in question, the access to this information was not agile, and was therefore irrelevant.

The use of AR can stimulate and help in the processes of knowledge and, according to Cardoso [9], both sides of the process can benefit; not only students, through the stimulus and ease of access, but also teachers by enabling different manners of teaching. Cardoso [10] affirms that use of AR stimulates and facilitates acquisition of knowledge by the student, helping teachers in their educational practices as well as providing various ways of teaching. The use of this methodology adapts very well to contents where the abstraction needed by the students becomes very complex.

Thus, in order to use mobile phones for helping to solve problems, this research presents a prototype of RAMED that aims to contribute to teaching human anatomy and that can be applied to different undergraduate courses that need it.

III. PROPOSAL

Society is increasingly looking for affordable and quality education.

The knowledge of human anatomy is fundamental for any courses that involve health and it has been one of the most complex and difficult subjects to learn. Even with the exhibition of anatomic parts in plastic and other tools, the students tend to be bored, since the content is very extensive. In this context, the possibility of an attractive and easy-to-read learning form, but one that maintains the quality of the classes, could prove useful.

In order to increase insertion of different technologies for teaching, AR with its many resources, if applied to the teaching of human anatomy can be an alternative to dynamize classes, making the visualization of the contents more interesting and contributing in this way to learning.

Anami [11] discusses AR immersion and navigation properties and the contribution each of them can make to the context of learning, mainly related to student involvement. She also talks about the interaction in AR environments, which provides links between student and content, students and teacher, and between students themselves. The benefits translate into better cognition, involvement, experimentation, collaboration, adaptation to rhythm and creation of appropriate environments.

Therefore, in order to use this technology for teaching human anatomy, the smartphone format was proposed, since it is considered to be a common and easily accessible tool for the majority of the population.

We provide a database of images of organs and systems, with visualization using AR technology.

It is assumed that a smartphone will provide greater learning effectiveness considering the ease of access and full availability of content. As a secondary benefit, it can dynamize classes by being a new instrument to aid teaching.

A. Materials

The construction of RAMED was a project conceived and carried by a group during the Mobile and Converged Networks course, a curricular component of the Graduate Program Course in Telematics at IFTO.

For construction of the prototype, the resources of the LAB MÁTICA physical laboratory of the Federal Institute of Education, Science and Technology - IFTO, Palmas - TO, were used. This lab has computers with an Intel Core processor I5-3330 with 8 GB of RAM and Ubuntu 16.04 LTS operating system. For the construction of the prototype the AppSheet [6] platform was used; this allows construction of group applications.

In August of 2018, the first test with the application prototype was carried out, with students of the Graduate Program in Telematics course as user. This audience of a total of 24 students, was chosen for the first design test because of the qualifications for evaluation and accessibility to the developers.

The main question focused on the usability of the application and the test with the prototype was able to provide answers. For access to the application, a link has been made available via WhatsApp [7].

IV. RESULTS

In order to learn about the evaluation of these first users, a questionnaire was produced using the Google Forms [8] tool and offered to users via a link released through WhatsApp [7]. The questionnaire was made available to 24 people and answered by a total of 8 people, who had access to the following questions shown in Table 1.

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TABLE 1- DESCRIPTION OF THE QUESTIONS AND ANSWERS RELATED TO THE QUESTIONNAIRE USED IN THE USER SURVEY.

Question	Responses	Percentage
1- Do you know what Augmented Reality (RA) is?	Yes	100%
2 - How much RA can assist in learning anatomy in your opinion.	It helps a lot	62,5
3 - Just by accessing the application can you recognize its purpose?	I recognize	50%
4 - How much do you understand that this application can be a learning support tool?	Very useful	75%
5 - As for the use of the app you would evaluate how?	Little Easy Normal	37,5% 37,5%
6 - As for the layout of the application you would evaluate how?	Great	62,50%
7 - As for the fonts used in the application would you rate how?	Great	50%
8 - As for the Icons and colors used in the application would you rate how?	Great	62,50%
9 - Were you satisfied with the content of the application?	Excellent	37,50%
10 - Any additional comments about the sessions or the programming as a whole?	None	0%

All responses were answered after using the prototype for the purpose of demonstrating its action.

A. *Data Analysis*

The user experience, visualized through the answers to the questionnaire showed broad knowledge regarding Augmented Reality (Fig. 1), a fact that was expected considering that the audience surveyed has an affinity with the computing area.

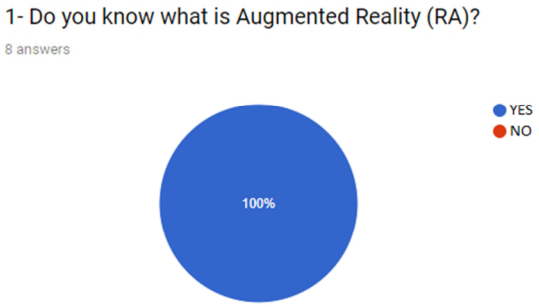

Figure 1 - Question 1 results.

Of this audience, 62.5% considered that Augmented Reality can contribute greatly learning anatomy, and 37.5% considered that it can contribute (Fig. 2). This demonstrates that Augmented Reality is already an established technology for aiding teaching and learning.

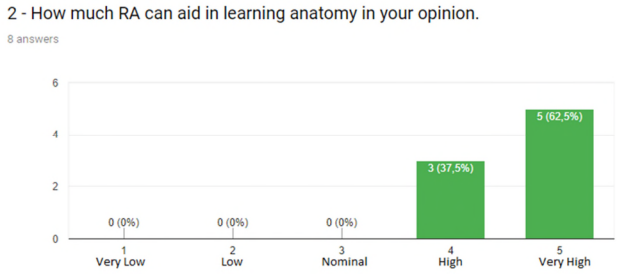

Figure 2 - Question 2 with the results on a sliding scale, where 1 is Very Low and 5 Very High.

Experience in using RAMED memory was reported by 12.5% of the surveyed public who reported that access to information was able to be fully realized. The others said they understood somewhat or understood very little (Fig. 3). This feedback demonstrates that the description of the purpose needs to be improved.

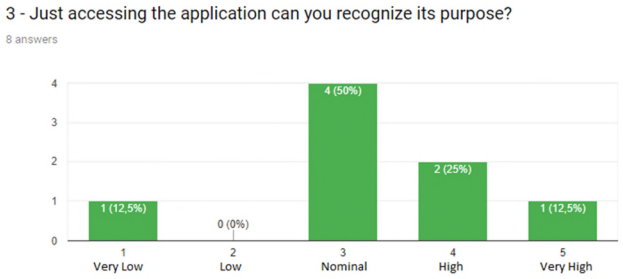

Figure 3 - Question 3 with the results on a sliding scale, where 1 means for I Very Low and 5 Very High.

In terms of the ability to develop a tool to support learning 75% said it had a great possibility of becoming the right type of tool, while 25% understood that there is some possibility (Fig. 4). This shows that although the goal may not have been well presented, the surveyed public understands that AR has the ability to be an educational tool.

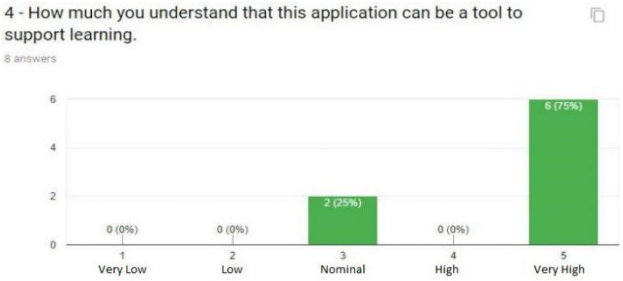

Figure 4 - Question 4 with the results on a sliding scale, where 1 is Very Low and 5 Very High.

The usability of the app was evaluated as very good by 25% of the public, good by 37.5% and fair by 37.5% (Fig. 5). As a result, we realize that improvements are needed.

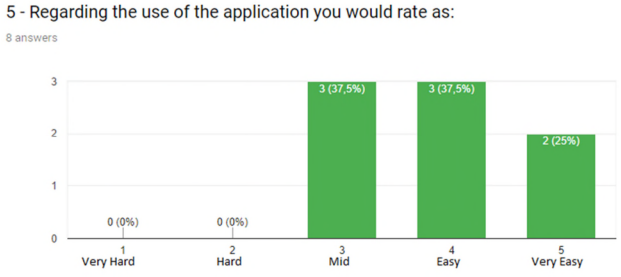

Figure 5 - Question 5 with the results on a sliding scale, where 1 is Very Hard and 5 is Very Easy.

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The layout was positively evaluated with 62.5% rating it as good, 25% as fair and 12.5% as very good (Fig. 6). From this, it is observed that the current project is of good quality, but needs improvement.

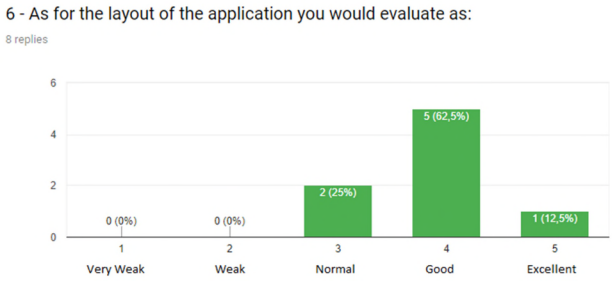

Figure 6 - Question 6 with the results on a sliding scale, where 1 is very weak and 5 is excellent.

The design was rated by 50% of the public as good, 25% as very good, 12.5% as fair and 12.5% as bad (Fig. 7). The fonts used in the words and images are subject to revisions, considering that they impact on the visual comfort and on comprehension of the screen and menus contents.

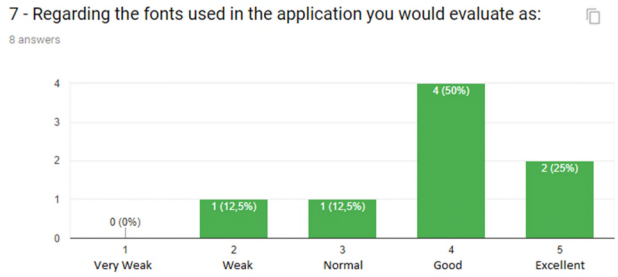

Figure 7 - Question 7 with the results on a sliding scale, where 1 is very weak and 5 is excellent.

The icons and colors presented received a positive evaluation when 62.5% evaluated them as good, 25% as very good and 12.5% as acceptable Fig 8.

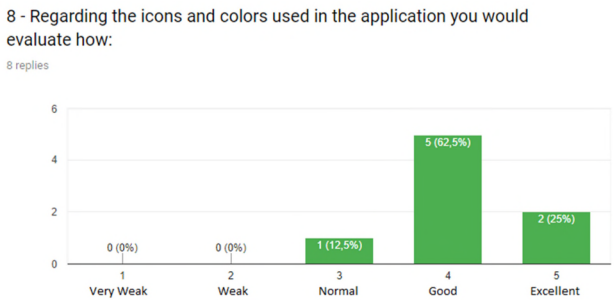

Figure 8 - Question 8 with the results on a sliding scale, where 1 is very weak and 5 is excellent.

The content available in the app was rated by 37.5% of the audience as very good, by 50% as good or acceptable, and by 12.5% as poor Fig. 9. The current content was inserted in the app for testing purposes; in the future it is intended for the teacher to insert the contents to be worked on in the classes.

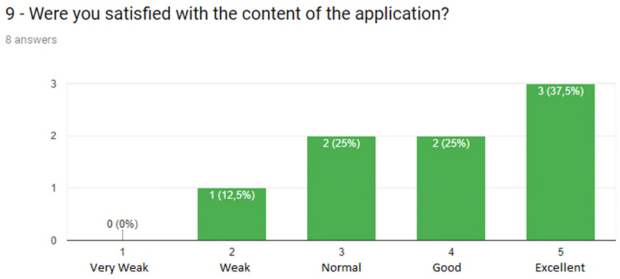

Figure 9 - Question 9 with the results on a sliding scale, where 1 is very weak and 5 is excellent.

Participants were asked for feedback and in this regard, and they pointed out failures in the operation of the buttons, suggestions as to the exchange and insertion of buttons on some screens and highlights for titles and images. Suggestions will be considered for future improvements in the app.

B. Description of the Prototype

The RAMED prototype, after four months in production, already has some functionalities ready such as: visualization of images of human organs in 2D, interaction by means of zoom, the possibility of consulting the menu for the course and downloading it and the possibility of giving feedback on use directly in the app. However, there are still other functions to be implemented such as Augmented Reality technology, the availability of high definition images and the definition of student and teacher users and their different operations within the app.

Some screens for the prototype are shown below.

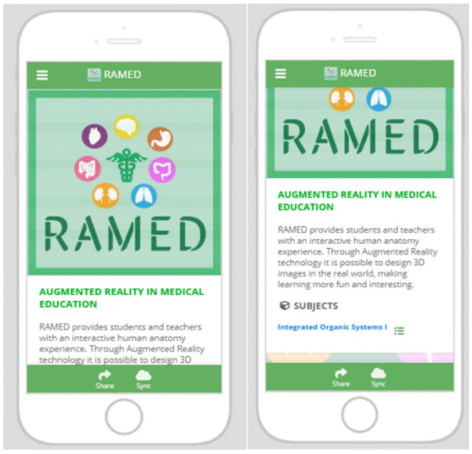

Figure 10 - Demonstration screens: initial with logo and shortcut for menu.

Figure 10 is a Home Screen. This is the presentation of the application where the drawings of human organs are placed, and the name of the application highlighted. On the same screen, there is also a description of the application and a link to the course content.

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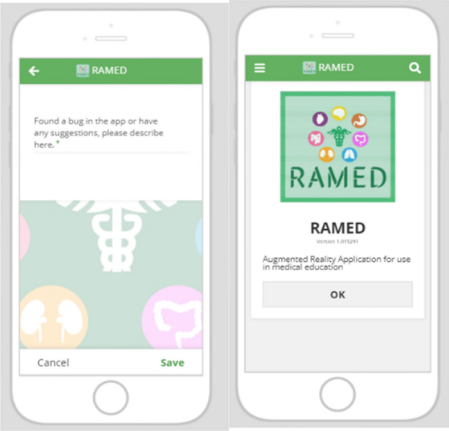

Figure 11 - Demonstration screens: About and suggestion and complaint screen.

Figure 11 is the screen for "Suggestions and Complaints" where the user can report their experience and suggest any changes. The goal is to better understand the user experience by enabling future improvements in the usability of the application.

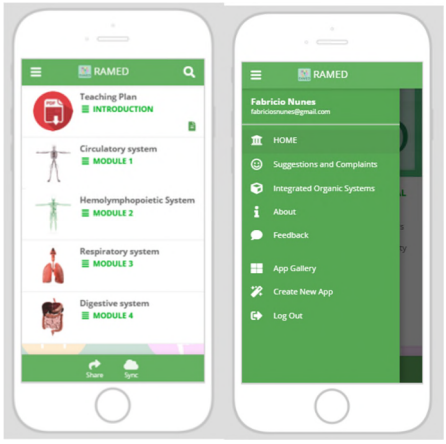

Figure 12 - Demonstration screens: side menu and suggestion and complaint screen and users choose the modules that divide the content.

In Figure 12 is the side menu with the application screen options. Each menu item directs the user to their needs. Note that the About, Feedback, App Gallery, Create New App, and Logout buttons will not be used for this app; the App Sheet platform [6] automatically inserts them. The available and functional buttons are Home, Suggestions and Complaints and Integrated Organ Systems.

The colors used are suggestive for the health area. There is also the screen with the application modules, where the contents are divided by a system with an illustrative figure on the side.

Figure 13 - Demonstration screens: Introduction screens.

Figure 13 is the "Introduction" screen, in which the content of each topic appears in summary form to facilitate the user's choice.

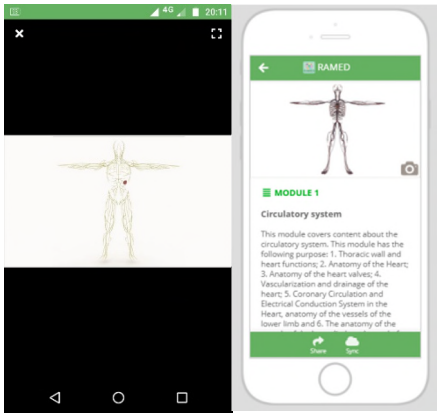

Figure 14 - Demonstration screens: Screen of the module with description of the content, and below the options of images and screen after choosing the image.

Figure 14 is the screen with module 1 which highlights the module number and the name. Below is a summary of the contents of the module. At the top is the figure representing the module. In the future the drawing in camera format will be the button to activate the AR attribute. On the right screen is the full screen image where the user can view the human tissues with resources for rotation, zoom and AR.

V. CONCLUSION AND FUTURE WORK

We can verify that the use of AR provides an important learning tool for healthcare students in that it invigorates the applied content, presenting a new way of interaction between students and the anatomical structures presented. This important new resource allows the teacher to explore a new universe where virtual reality guides the students in approaching the objects of their studies.

Despite the fact that the project is still at an early development stage, it already presents practical uses by providing the students with a database of images accessible

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on the mobile device, facilitating visualization and study of the anatomical structures.

Even though the app is based on the resources provided by AR, at this stage of the project it is limited to the tool used for testing the prototype. The implementation of this important resource is planned for the next phases of development of the project.

In the near future, research will be conducted with the target audience in order to ascertain the effectiveness of the tool among students. Field tests will be carried out with undergraduate students in human anatomy, such as medicine, nursing, physical education and physiotherapy at higher education institutions located in the city of Palmas, Tocantins, Brazil.

Improvements will be made to the format with a focus on usability, utility, and content reliability. Teachers will also be consulted to give their opinion on the format.

The augmented reality feature will be implemented and access to it will be on the image preview screen, specifically through a button in camera format, as shown on the prototype screen in image 14. Titles will be inserted on each screen in order to improve the notion of location for the user.

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