Research article

Perception of health programme students on the use of an augmented reality tool in anatomical practices

Percepción de los estudiantes de programas de salud sobre el uso de una herramienta de realidad aumentada en prácticas anatómicas

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Abstract

Introduction. Augmented reality in the medical field has continuously grown, supporting theoretical and practical components. This technology presents a safe environment for experimentation for health science students. **Objective.** This research analyses the acceptance of health science students with the augmented reality tool HOLOMARKERS. It allows the user to place virtual pins on human biological material to achieve labelling of tissues, muscles, and organs, avoiding direct contact with the sample. **Methodology.** A technology acceptance model analyses the influence of HOLOMARKERS on student acceptance. Each core of the model has four Likert-scale questions. The sample size surveyed is 17 health science students. Four cores structure a technology acceptance model: theoretical background, acceptance of use, perceived ease of use and perceived usefulness of use; analyses of the acceptance of HOLOMARKERS by students. **Results.** Perceived usefulness of the tool and the students' previous theoretical background influence the acceptance of tool. **Conclusion.** The students surveyed highlighted the usefulness of HOLOMARKERS for developing practices in the macroscopic anatomy laboratory with human biological material.

Keywords: Augmented Reality, Anatomy, Technology Assessment (DeCS/MeSH).

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Resumen

Introducción. La realidad aumentada en el campo de la medicina tiene un crecimiento continuo, brindando apoyo en componentes teóricos y prácticos. Esta tecnología presenta un entorno seguro para la experimentación de estudiantes de ciencias de la salud. **Objetivo.** La presente investigación analiza la influencia sobre la aceptación de estudiantes de laboratorios de morfología con la herramienta de realidad aumentada HOLOMARKERS. Esta herramienta permite al usuario colocar alfileres virtuales sobre material biológico humano para un etiquetado de tejidos, músculos y órganos, evitando contacto directo con la muestra. **Metodología.** Para analizar la influencia de HOLOMARKERS en la aceptación de los estudiantes, se usó un modelo de aceptación de la tecnología. Cada uno de los cuatro núcleos del modelo se constituye por cuatro preguntas en escala Likert. El tamaño de la población encuestada fue de 17 estudiantes de ciencias de la salud. **Resultados.** La aceptación de HOLOMARKERS por parte de los estudiantes es influenciada por la utilidad percibida de la herramienta y la formación teórica previa de los estudiantes. **Conclusiones.** Los estudiantes encuestados resaltan la utilidad de HOLOMARKERS para el desarrollo de las prácticas en el laboratorio de anatomía macroscópica con material biológico humano.

Palabras clave: Realidad aumentada, Anatomía, Evaluación Tecnológica (DeCS/MeSH).

Introduction

Since 2020, educational institutions have rapidly integrated new technological elements into academic training (1). This change in education challenges teachers to implement virtual laboratory practices, especially in careers such as engineering and health sciences (2). Health science laboratories present biohazards due to accidents, and the biological material used in laboratories is scarce and subject to constant wear and tear (3). Extended reality: virtual, mixed and augmented (4), has been steadily growing in different areas of knowledge. These technologies provide quick access to information (5,6), developing research methodologies in universities, learning alternatives and interaction between students and teachers(7–9).

Augmented reality in healthcare supports primary science teaching (10) and minimally invasive surgery training (11,12). Improving the learning curve with a safe practice environment for students (13,14), anomaly detection (15), large-scale histological studies (16), microsurgery and pathology training (11,17), and the implementation of telemedicine practices (18,19). These advantages are notable when employing specialised devices with natural integration for users (20,21). These applications lack markers to recognise the manipulated structures' names (22–25). Some of the difficulties of augmented reality in healthcare are the complexity of simulating environments in a real surgical procedure and the design of human-computer interfaces to facilitate interaction with the applications (20).

One technology that compensates for previous difficulties is HoloLens, used in different augmented reality applications. In (26), the authors evaluated mixed reality with HoloLens for teaching macroscopic and microscopic anatomy of the respiratory system; it is an effective teaching tool with a favourable learning experience. In (27), the investigation develops a model of a face with all its structures using HoloLens as an alternative for teaching anatomy and compensating for the scarcity of human biological material, achieving an immersive experience with an accurate 3D perception of the face.

The present research analyses the acceptance of students in face-to-face morphology lessons with the augmented reality tool HOLOMARKERS. The tool aims to support the teaching processes of human anatomy, to compensate for the scarcity and deterioration due to the use of human biological material, and to reduce possible accidents in the Macroscopic Anatomy laboratory of the Department of Morphology of the Faculty of Health Sciences of the University of Cauca.

Material and methods

The present research had a quantitative approach with a non-experimental cross-sectional design, where the universe consisted of undergraduate students of the Faculty of Health Sciences. The population limit was 80 second-semester students who were taking the subject of Morphology. The sample calculated probabilistically (28), with a confidence level of 75%, was 17 students under the following inclusion criteria: to be over 18 years old, to be enrolled in a programme of the Faculty of Health Sciences and to be taking the subject of Morphology. Finally, after the socialisation of the project, its scope and limitations, the participants accepted and signed an informed consent form.

Holomarkers

HOLOMARKERS is an augmented reality tool to support the morphology course for medical, nursing, physiotherapy, and speech therapy students. The base of HOLOMARKERS is Microsoft HoloLens 2. Its functionality consists of placing virtual pins with labels created by users on dissected human bodies to identify different parts of the body, avoiding direct contact with the biological material to reduce its deterioration and minimise the user's biological risk. HOLOMARKERS has two user interfaces: a) a web interface accessible from different browser-based devices and b) the augmented reality application for Hololens 2. The tool manages data from a conventional web interface (desktop and mobile) under a client-server architecture to bridge the applications (figure 1). The tools required for developing HOLOMARKERS are NodeJS for the server, MongoDB for the database, and ReactJS for the client web application.

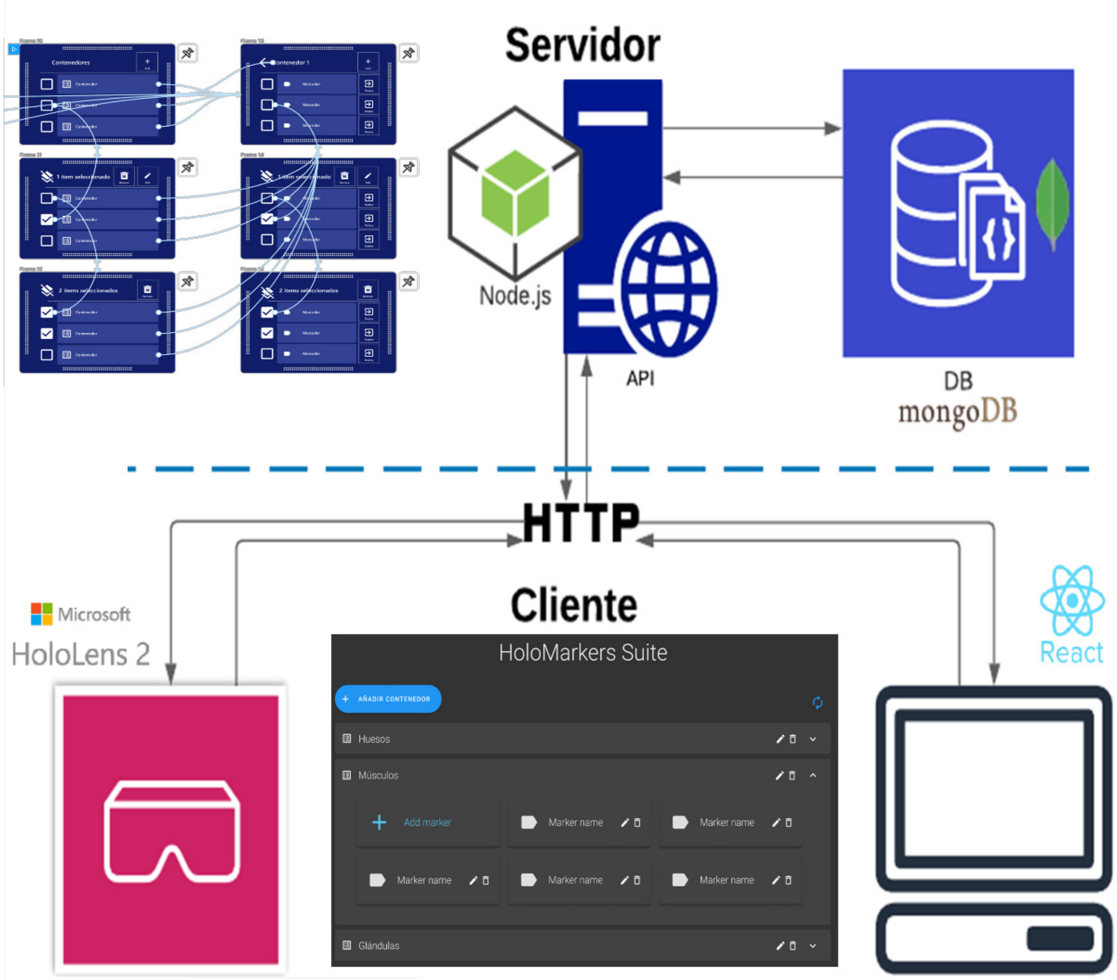

Figure 1. General HOLOMARKERS web application mockup.

Survey design

The research aims to evaluate the parameters that influence the acceptance of HOLOMARKERS by health students using a structural equation model based on TAM (29). The main core of the analysis is the acceptance of HOLOMARKERS by students. The four research hypotheses are:

- h1. Theoretical background of the students positively influences the perceived usefulness of HOLOMARKERS.

- h2. Theoretical background of the students positively influences the perceived ease of use of HOLOMARKERS.

- h3. Perception of use positively influences the acceptance of the use of HOLOMARKERS.

- h4. Perceived ease of use positively influences the acceptance of the use of HOLOMARKERS.

The four building cores are:

- Theoretical background (TB), level of theoretical training of students before using HOLOMARKERS.

- Perceived Usefulness (PU) is the degree to which students feel that HOLOMARKERS improves their teaching process.

- Perceived ease of use (PE), students' degree of difficulty in using HOLOMARKERS.

- Acceptance of use (AU), how much students like HOLOMARKERS after using it.

The core constructs have four seven-level Likert-scale questions. A series of three open-ended questions seek advantages, disadvantages and improvements of HOLOMARKERS as perceived by the students. The questions are in a questionnaire validated through expert evaluation. The statistical analysis tool R (30) assessed the acceptability of the hypotheses set out, with 500 samples generated by bootstrapping.

Results

User Experience

A set of HOLOMARKERS tests with teachers attached to the Department of Morphology of the Universidad del Cauca qualitatively evaluated the user experience concerning ease of use and interaction (figure 2) and allowed for debugging at the methodological and software level prior to use by students.

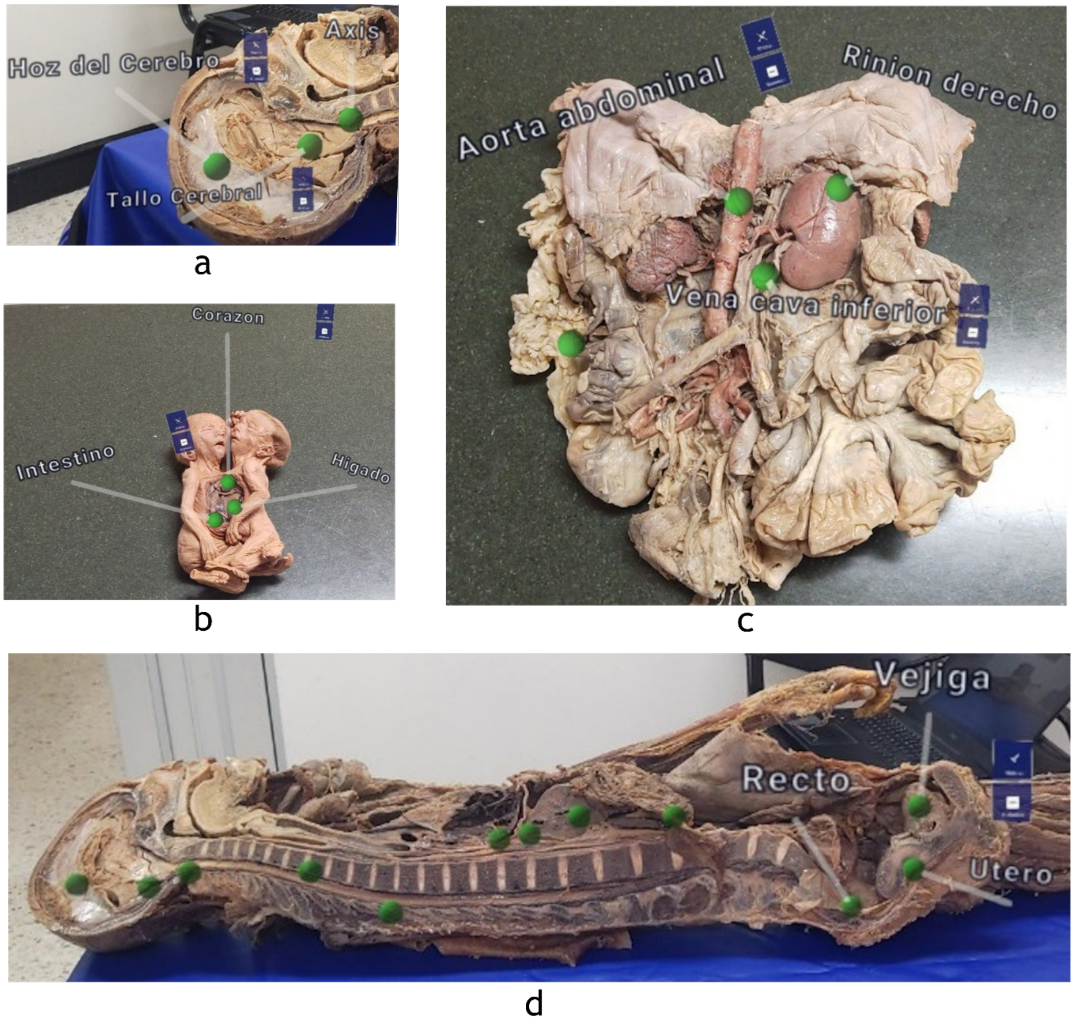

Figure 2. Experience of using HOLOMARKERS in a) Sagittal section of the brain. b) Siamese twins 24 weeks of gestation thoracopagus. c) Block in posterior view of the retroperitoneum and abdominal contents. d) Female pelvic organs in sagittal section. ***Source:*** The authors.

Feedback from teachers highlighted favourable aspects of traditional teaching methods:

- Improvements in the organisation and visualisation of internship content.
- Generate higher-quality digital content to support laboratory practices. - Biohazard risk reduction.

The difficulties highlighted by teachers were:

- Need for the training of Hololens 2 glasses to learn the different gestures supported to interact intuitively with the tooltips and other virtual elements.
- Sometimes, the tooltip size is small, making it challenging to perform interactions.

- Difficulty manipulating tooltips due to proximity to other objects in the real world colliding with the limit set by Hololens spatial recognition.

The investigators considered this information before the test with the students.

Survey Processing

According to surveys' statistical processing (Table 1) with an α-value of 0.05, all hypotheses are valid, with a positive influence among the respective cores. The exception is hypothesis 3, whereby the acceptance of using HOLOMARKERS does not depend on the perceived ease of use by the students.

Table 1. Evaluation of the HOLOMARKERS acceptance parameters.

Hypothesis	Trajectory	Bow weight	Standard error	t-test	p-value	Confidence interval 95% percentile	Hypothesis validation
1	FP<- FT	0.7372	0.17	4.3354	< 0.0001	[0.593; 0.923]	Accepted
2	UP<-FT	0.6956	0.1687	4.1239	< 0.0001	[0.678; 0.9003]	Accepted
3	AU<-FP	0.3269	0.2488	1.314	0.1889	[-0.435; 0.779]	Rejected
4	AU<-UP	0.6473	0.2267	2.856	0.0043	[0.123; 1.215]	Accepted

Similarly, the indirect effect of students' theoretical background on HOLOMARKERS usage acceptance obtained an arc weight of 0.6912, a standard error of 0.1648, a t-test of 4.1952, and a p-value of less than 0.0001. Therefore, the indirect hypothesis is accepted.

Discussion

The statistical processing of the structural model highlights HOLOMARKERS as a tool to support the practical learning of students, who must have a prior theoretical foundation to carry out the practices and adequately assess the benefits provided. Likewise, the usefulness perceived by the students affects the acceptance of using HOLOMARKERS.

Regarding the disadvantages of HOLOMARKERS, the students' open responses highlight improving the size of the marker, along with the visibility of the markers by providing more colours to place the markers on the biological material. Among the advantages expressed by the students, it stands out that it is a fast and intuitive interface that achieves a union between reality and virtuality. This overview achieves didactic laboratory practices that allow working with the same biological material without affecting or overlapping the information from one practitioner to another (Figure 3).

Figure 3. a Disadvantages

Figures 3. b Advantages

Figure 3. Word clouds of students' comments to HOLOMARKERS.

Among the aspects to be improved in HOLOMARKERS, it is necessary to refine the markers' size, colour, and visibility. Likewise, before the laboratory practices, a familiarisation guide should be carried out to ensure the intuitive and straightforward use of HOLOMARKERS for the end user to use all the features provided.

Conclusions

In conclusion, the augmented reality tool HOLOMARKERS supports the morphology course practices for medicine, nursing, physiotherapy, and speech therapy careers. HOLOMARKERS allows interaction with different samples of biological material without coming into physical contact with them, reducing the biological risk by accident and helping to preserve biological material.

The characteristics of HOLOMARKERS, students' theoretical background and ease of use influence students' acceptance of the tool. These results indicate that before performing any laboratory practice, the student must have the basic knowledge to have a good learning process and perceive the benefits of HOLOMARKERS. The students' perception highlights the usefulness of HOLOMARKERS for developing practices in the macroscopic anatomy laboratory with plastinated material and material preserved in formaldehyde and carbolic acid.

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Conflict of interest

The authors manifest that there is no conflict of interest in this research.

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