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Blueprinting an edu-centric design and development workflow for a prototype mixed reality neuroanatomy resource.

Panagiotis E. Antoniou[1]*, George Ntakakis[1], Emmanuil Babatsikos[1], Alkinoos Athanasiou[1], James Pickering[2] and Panagiotis Bamidis[1*]

1 Medical Physics Laboratory, Medical School, Aristotle University of Thessaloniki, Thessaloniki 54124, Greece
2 Division of Anatomy, Leeds Institute of Medical Education, School of Medicine, University of Leeds, Leeds, United Kingdom

*corresponding author, pantonio@otenet.gr, gntakakis@outlook.com, manwlisbabatsikos@yahoo.com, alkinoosathanassiou@gmail.com, J.D.Pickering@leeds.ac.uk, bamidis@med.auth.gr

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1 Introduction.

Mixed reality (MR) is an immersive modality similar to augmented reality (AR), but with one key difference; instead of the real world marker being a pre-programmed static item or image, the content overlay is done after completing a 3D mapping of the current environment. This way features can be used in intuitive ways such as tables-positioned 3D models or 2D images and "hanging" notes on walls. There is evidence that such technologies significantly increase the educational impact of an episode of learning and subsequently can have a significant impact on educational outcomes [1]. Realized examples include the incorporation of such modalities for VPs [2]. It is this immersive capacity of these modalities that allows the educational material to be internalized, avoiding conceptual errors [3]. This work presents an approach for the creation of immersive digital content for medical education based on participatory design processes in order to permeate it with content and context of the topical information.

2 Materials and methods.

4 use cases were explored for use of the immersive resource. The one selected for implementation was a lecture oriented exploratory review of the ascending and descending pathways of the central nervous system. This was chosen as the most straightforward methodological modality that is immediately relatable to the everyday practice of anatomy education. The, codenamed “HoloAnatomy”, MR application in HoloLens

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was conceived as a teaching aid for the lecturer. With that, we aimed to have a holographic "Mannequin" that would take the role of the anatomical cadaver and would present specific educational immersive material on the specific topic of ascending and descending pathways of the central nervous system. The scenario was story boarded based on the narrative of the lecture. After an initial introduction to the topic by the lecturer, the flow of the lecture would shift to the MR application, which would be projected for all users to follow.

3 Results.

The first part of the presentation included a short visual depiction of the human body. After that, a transparent depiction of a human body was presented with the only structure visible being that of the Spinal Cord (SC). The user had the capability, through the app, to select specific sections of the SC, the Pons, the Medulla or the Midbrain. There the lecturer could select one of four ascending or descending neural pathways to be depicted in each section either separately or altogether with different colorcoding. Finally, the lecturer, through a split view of the two hemispheres of the brain could demonstrate where each pathway reaches the cerebral cortex. A demonstration panel was also present for showing selected structures at all times.

The core of the edu-centric approach for the development of "HoloAnatomy" deviated from the standard software development process of requirements elicitation, design and development. Instead, it consisted of an iterative cross-disciplinary process for immersing the developers in the medical topics and the medical experts in the design processes of the digital resource. The process involved several sessions in which the medical experts actually educated the developer team in the medical topics in order for them to anticipate implementation hurdles. Also, the technical team reciprocated by familiarizing the medical educators with the technical limitations and opportunities of the medium and platform so that they make informed design choices in their iterative requests for features. This smooth development process had the added benefit of transferring useful, digital skills to the lecturer and participating medical experts so that they can be maximally efficient when they use the resource in the classroom.

The application was developed in Unity3d for the Microsoft HoloLens. After the iterative educationally centric design process, the "HoloAnatomy" application was created with just some shifts in the presentation. The core flow that was storyboarded was maintained with two caveats. The initial provision for a panel on which each section of the spinal cord would be presented has been determined by the lecturer to be disorienting. The transition between the full anatomical body and the panel was confusing both the lecturer and possibly the students. Thus, it was deemed necessary to be removed and the selected sections of the CNS to be presented mid-air in front of the whole human depiction. Beyond that, the lecturer requested that we implement two modes of presentation in the application. One "lecturer" mode and one "exploratory" mode. The first would be liner, with arrows to move forward and backward in the application's narrative so that the lecturer could focus in presenting the material during his presentation the second would be available for questions and discussion, where the lecturer could easily jump from place to place and explain things immediately as needed.

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4 Discussion and future work.

A pilot evaluation of 200 students (125 control 75 MR assisted) by the authors explored anatomy teaching using MS Hololens versus screencasts for lesson support was conducted and the results, as have been presented in a joint symposium in AMEE2018 [4] demonstrated that no significant differences have been observed between the two teaching modes. These results suggest that this resource development pipeline did not adversely affect the educational process. In addition, the use of the resource as a straight lecture aid did not tap into the strengths of seamless interaction and immersion of the MR resource. It is expected that through more learner-centric incorporation of such resources their true potential will be realized.

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