An interactive mixed reality application for anatomical and surgical education: 3D learning in relation to spatial ability

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Background: Medical students mainly learn anatomy using 2D content information. Spatial ability seems to be a successful predictor of deep anatomy learning and acquisition of technical skills. Previous studies have repeatedly shown, that especially students with lower spatial ability, have difficulty with transferring 2D knowledge to the clinically relevant 3D domain. The aim of this exploratory trial was to evaluate how spatial ability relates to anatomy learning using 3D content information.

Method: We developed a fully interactive mixed reality application for Microsoft Hololens. This application represents a holographic dynamic model of the lower leg and foot, including a complete musculoskeletal system. In a double-centred randomized controlled trial, 1st and 2nd year undergraduate medical students were randomized in three groups: holographic 3D model, non-stereoscopic 3D desktop model and traditional 2D anatomical atlas. Before the tutorial, spatial ability was tested for three spatial components: mental rotation, mental transformation and mechanical reasoning. All students did the same tutorial on the anatomy of musculoskeletal system. A written posttest was administrated to evaluate the learning effect on factual, functional and spatial anatomical knowledge. The utility and usability of our developed MR application was also evaluated.

Discussion: We hypothesize that students with high spatial ability will outperform students with low spatial ability in all three learning modalities. Moreover, we hypothesize that students with low spatial ability will benefit most from learning in 3D with the use of an interactive holographic model, compared to non-stereoscopic 3D desktop model and 2D textbook. The main learning effect is expected to be observed on the functional and spatial knowledge domains. The final goal of our project is to design a method for personalizing learning paths and providing individual students with the most efficient learning tools. Our preliminary data of current study will be presented including a showcase of the developed mixed reality application.

Conclusion: Mixed reality provides a total new environment for three-dimensional learning. This innovative educational tool may be an ideal way to facilitate personalized learning in anatomical and surgical education.

8K2 (2989)
An Exploration: Applying Cognitive Theory of Multimedia Learning to Anatomy Teaching

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Background: Anatomy is a cognitively demanding subject that requires stimulation of both audio and visual channels. Didactic lectures are not sufficient to teach and/or learn it. In contrast to conventional medical training which uses cadavers, anatomy practical at the University of Botswana Faculty of Medicine (UBFOM) is through Anatomage 3D Imaging Table (Anatomage Inc.) and anatomical models. Typically, the anatomy practical is preceded by a fifty-minute plenary. Later on, they attend the first PBL tutorial where they are expected to integrate anatomical knowledge gathered from these earlier sessions. Learners enter medical school having completed one-year basic sciences including an introductory course on anatomy using a didactic approach.

Method: Two learning tasks from anatomy practical were analysed using Mayer’s cognitive theory of multimedia learning (CTML). This theory is premised on promoting retention and transfer of knowledge. We reviewed materials provided by the lecturer and, did observations of students undertaking these tasks. We also conducted separate interviews for learners and the lecturer using the CTML framework. These learning tasks involved first year medical students from a five-year spiralling Problem Based learning (PBL) Bachelor of Medicine and Bachelor of Surgery (MBBS) programme at the UBFOM. The tasks were focused on learning anatomy of the lower
respiratory tract by using anatomage table and anatomical models. **Results:** From the analysis, the use of auditory and visual pathways seems to be relevant to both the teaching and learning of anatomy. Both tasks fulfilled most principles of CTML. Eight out of twelve principles of CTML were fulfilled. The learning objectives of the two tasks were observed to be at a lower level in the revised Bloom’s taxonomy. **Conclusion:** Learners found anatomy demanding. They reported difficulties in learning new anatomical terminology as well as integrating the material covered in anatomy sessions including the PBL tutorial. The use of images and words promoted learning of anatomy. **Take-home message:** We recommend that CTML should be applied in teaching anatomy to optimize learning.

8K3 (1810)
Anatomy for Pharmacists: Creation of an anatomy syllabus to support the changing role of the pharmacist

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**Background:** This study describes the creation of a core Anatomy syllabus for Pharmacy students. The syllabus was developed to support the changing role of the pharmacist from one that was traditionally based on dispensing to one that encompasses treatment, diagnosis and acting as the first port of call for patients. With respect to this change, it is both timely and important for pharmacy graduates to have a strong anatomical foundation upon which to build their pharmacological knowledge and skills. **Method:** The Delphi approach was employed to seek consensus on which learning outcomes should be included in such a syllabus. The Delphi panel was constructed to include ‘experts’ who were individuals from different professional backgrounds with experience of teaching pharmacy students anatomy. The Anatomical Society’s council and education committee nominated the panel members. The resultant panel had 34 experts. Using existing frameworks, the research team performed an initial screen of outcomes to remove outcomes that were obviously not applicable (n=10). The experts were asked in two stages to ‘accept’, ‘reject’ or ‘modify’ (first stage only) each learning outcome. A final formatting was performed by the research team to standardise presentation, make changes either to correct any anatomical or minor syntax errors

**Results:** During stage 1, 163 outcomes were presented to the Delphi panel. Following stage 1, 53 outcomes remained and 49 after stage 2. The final syllabus contained 49 learning outcomes. Each outcome was mapped to possible teaching content within an integrated curricula. All learning outcomes achieved over 80% acceptance by the panel. **Discussion:** The Delphi process offers a useful tool for creating such syllabus with the input of multiple, valued stake-holders. The new syllabus presents a basic anatomical framework upon which pharmacy educators can build the necessary clinical practice and knowledge. **Conclusion:** The learning outcomes within the syllabus could be utilised to develop anatomy teaching within an integrated curriculum. At present, there are limited requirements from professional bodies, such as the General Pharmaceutical Council (GPhC) and the British Pharmacology Society, for anatomy standards – this syllabus is a first offering at filling this gap.

8K4 (3504)
Learning from an interactive online platform: Anatomy in the inter-professional operation room (OR)

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**Background:** Unfortunately, many students in medical education perceive basic subjects such as anatomy or physiology to be quite dull, as the knowledge is taught by books, lectures or in prospection courses that rarely illustrate the clinical relevance of anatomy. We assume that anatomical knowledge needs to be more linked to clinical application. Therefore, the University of Tuebingen offers the Sectio Chirurgica (SC), an online video platform where healthcare students and professionals have the opportunity to join surgical live-stream lectures that explicitly integrate pre-clinical anatomical education and clinical application. **Method:** In order to examine whether SC videos are capable to support participants’ learning activities by linking basic knowledge to clinical application, we conducted a randomized controlled online trial to compare this innovative format with a “classical” anatomy lecture. 168 medical students were recruited from the SC user panel and randomly assigned to one of two conditions. The experimental group watched a 15 minutes SC video about an ACL reconstruction surgery. While 2/3 of the video showed inter-professional interactions in the OR, 1/3 of the video showed a professor providing anatomical
Results: Our participants perceived SC videos as significantly more comprehensible (p < .01), more vivid (p > .01), and more entertaining (p < .01) than the lecture videos showed in the control condition, whereas no significant differences were found regarding anatomical knowledge (p = .35). Our results show that SC videos are a promising solution to improve anatomy learning as the live presentation of clinical situations was perceived as more comprehensible and more vivid. However, short term learning results did not differ between conditions. Since participants reported that the SC video was also more entertaining, we assume that dynamic interaction of clinicians and anatomists is important for student's learning motivation.

Conclusion: Compared to classic anatomy lectures, SC videos made anatomy more attractive and especially tangible to medical students.

8K5 (3591)
DynamicAnatomy, an interactive augmented reality application for higher education

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Background: Deep learning of anatomy is an essential part of medical education. Students mainly learn anatomy using 2D content information. We and others have found that students and (surgical) residents often have difficulties with transferring this knowledge to the clinically relevant 3D domain. In addition, undergraduate students have limited time and access to “tools” to practice their anatomy skills.

Method: We developed a prizewinning interactive Augmented Reality application for Microsoft HoloLens® ([https://insider.windows.com/nl-nl/community-news/windows-insiders-are-using-hololens/](https://insider.windows.com/nl-nl/community-news/windows-insiders-are-using-hololens/)). This application is called DynamicAnatomy and is freely available for download from the Microsoft Store. It shows a dynamic model of the lower leg and foot with functional tibiotalar and subtalar joints. It is fully interactive in showing/hiding all bones, muscles, tendons and ligaments, blood vessels and nerves, in providing online information about all selected objects, and in joint motion by means of animations, manual interaction, and by live synchronization with your own ankle movement through

8K5 (2055)
Integrating the Anatomage Table into an Anatomy Curriculum: a qualitative analysis of student perception

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Background: The absence of cadaveric dissection or prossection in the PU PSMD course was a conscious decision to constructively align teaching to the clinical experience of patient interactions, via surface anatomy and medical imaging. The use of innovative teaching approaches has been the mainstay of this Medical School, and developing and incorporating technology into the anatomy curriculum is an aspect that yields high student satisfaction. The Anatomage virtual dissection system was purchased to offer students an additional modality to explore anatomy, with a depth of detail rivalling dissection and prossection. The aim of this study was to understand student perception of the Anatomage system, how they use it and factors affecting their engagement with it. It aimed to inform curriculum design and self-directed learning (SDL) tools that would enable effective use of the Anatomage system.

Method: This study utilised thematic analysis directed by grounded theory. Focus groups included 6-10 year 1-2 students providing detailed narratives to be gathered for analysis. Thematic analysis began with an inductive approach, based on the focus group data, followed by a deductive approach, grounded in an understanding of the relevant literature and prior experience, which informed the coding. Reflexive diaries were kept by the researchers, to identify any biases.
motion capture. In addition, arthrodesis of the tibiotalar joint is presented as a clinical case (https://www.mr4education.com/).

**Results:** We integrated this innovative educational tool in the 2017-2018 Medical Curriculum in various courses and performed preliminary research to the relation between 3D cognition, 3D cognition, and learning outcomes with this Mixed Reality tool. Students report an immersive and deep learning experience which greatly adds essential 3D insights to their prior (2D) knowledge. Intrinsic motivation appears boosted, although we cannot rule out a first pass “gadget” effect at this stage. Students further report preferences compared to VR because of (1) the possibility for explorative and collaborative learning, and (2) learning comfort: they don’t get dizzy because HoloLens is a look-through device. In addition, they appreciated the chance to practice anatomy in a safe and authentic setting. Quantitative data will be gathered during the first months of 2018 and will be reported on AMEE2018.