PTAS Project Report (for REGULAR PROJECT GRANTS)

Project Title: EdAR – Educational Apps in Augmented and Mixed Reality

Project type (delete as appropriate) :
B Innovation Project (introduction and evaluation of an educational innovation, usually taking a practical approach)

Principal Investigator : Dr Andrew Sherlock
Schools/department : Engineering (Mechanical)

Team members (including Schools and Departments) :
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School: Medicine

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School: Edinburgh College of Art

For further details, please contact:

Project teams must submit a report within 4 months of the conclusion of their project.
Copies of dissemination material (eg journals/newsletter articles, conference papers, posters should be listed and attached (separate to the word count). The brief report will be published on the IAD web pages.

Report (maximum 1500 words)

What did you do?

The Principle Teaching Award Scheme (PTAS) project involved making pilot educational augmented reality (AR) applications to promote digital technology in teaching for 3 stakeholders: The University of Edinburgh Medical School, The University of Edinburgh School of Biological Sciences and John Gillespie's high school (JGHS).

This project aimed to address the 'adoption gap' by looking to identify and develop 3 pilot apps. The applications that were developed were the "Biology protein synthesis Application" in

collaboration with the School of Biological Sciences, UoE, the “Orthopaedics Application” in collaboration with the Medical School, UoE, and the “AR Computational Fluid Dynamics (CFD) Application” in collaboration with the John Gillespie's Highschool.

University of Edinburgh Medical School

With the aid of Dr Gavin Brown, Senior Clinical Lecturer in Orthopaedics and Digital Education, we created an AR Orthopaedics application. The AR application aids the understanding of complex geometries, for example a human pelvis, in X-rays and Computed Tomography (CT) scans.

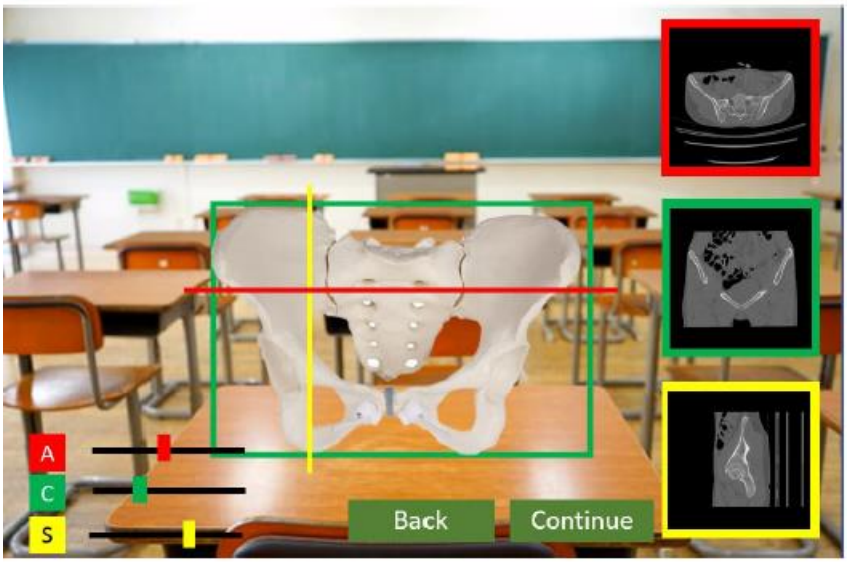


Figure 1: Storyboard representation of the AR Orthopaedic application

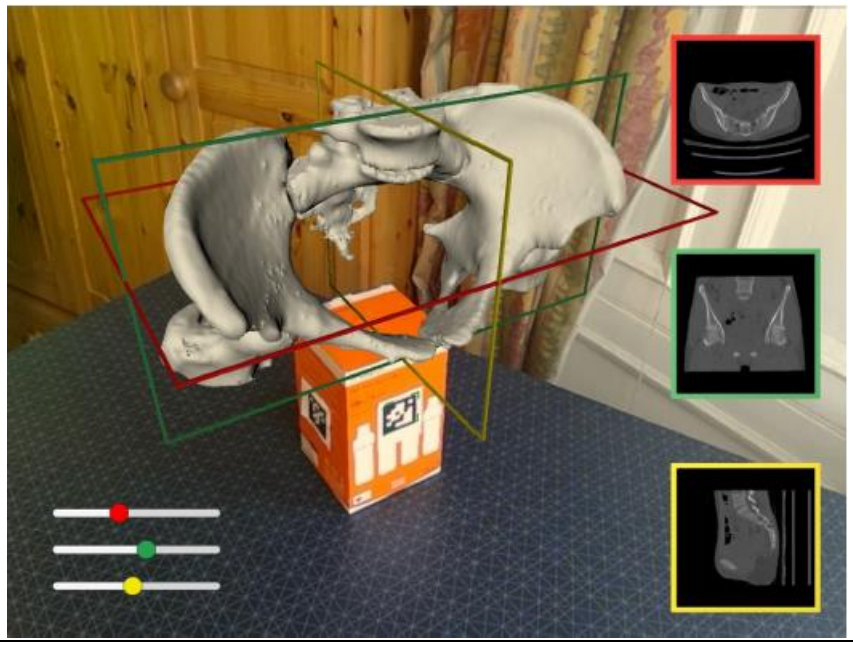


Figure 2: AR Orthopaedic application

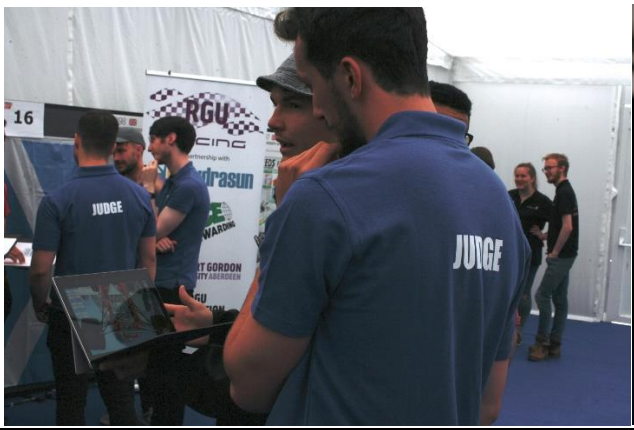
University of Edinburgh School of Biological Sciences

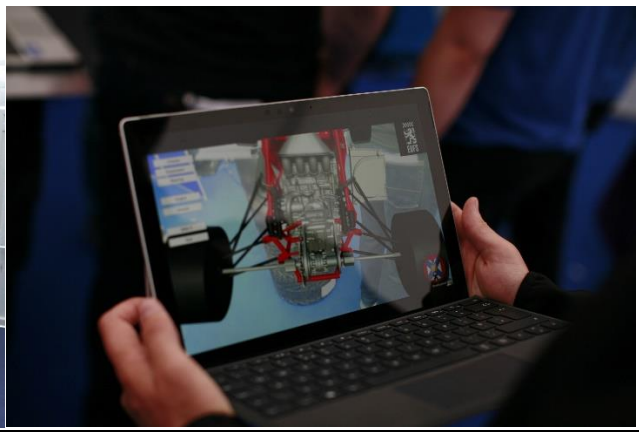
The General Protein Application is an augmented reality enhanced educational experience developed in collaboration with the University of Edinburgh, School of Biological Sciences. It is a block-based visualisation of protein synthesis. The application is developed in Unity and resembles a Minecraft environment where the user can learn about proteins by synthesising them based on a constructivist approach.

Figure 4: AR General Protein application

James Gillespie's High School

James Gillespie's High School worked with ONAIR, S6 Student-led Formula One in schools' team, to make an AR Computational Fluid Dynamics (CFD) display to aid the students in their presentations for the Formula One in schools' competition. We superimposed the CFD results on top of the car within their wind tunnel to compare experimental and theoretical results. For their wind tunnel and AR CFD display, ONAIR won the Research and Development Award at the Scottish Formula One in schools' competition.





(a) Student showing the CFD to the judges(b) Student explaining the CFD

Figure 5: JGHS's ONAIR at the Formula One in schools' competition

During this project we managed to identify areas where AR/MR would be appropriate, built a better understanding of approaches to design of teaching, learning and assessment in AR/MR, developed inhouse expertise in the practical development of AR/MR apps, and raised the profile of AR/MR in the student community therefore achieving the aims we set up for this project in the PTAS proposal.

By the end of the project, we achieved the following objectives:

- developed 3 pilot apps
- evaluated the 3 apps
- supported AR app production by student teams such as the Formula Student
- surveyed the University's current stock of AR/MR hardware available for teaching
- determined in which subject areas AR/MR offers most benefits

What did you find out?

Augmented reality can enhance teaching more than a textbook. The advancing technology of AR allows for interactions between real objects and virtual objects to allow for better understanding of complex geometries. By using AR, students can experience and interact with the objects or procedures in detail, simply using a smartphone, tablet, or AR glasses. This makes AR highly effective when teaching geometric and spatial concepts, often found in science, technology, engineering, and math.
The PTAS project showed that the use of AR in educational activities has been very successful and characterised by the participants as a fun way of learning and understanding complex geometries and concepts.
Students who took part in this project found the prospect of using AR fascinating and commented that they would like it to be part of their curriculum since they felt it enriched the learning process.

How did you disseminate your findings?

The successful implementation of the PTAS project helped to inform the planning and future investment by the University in these technologies which seem likely to be an important component of any future digital education strategy. This interest around the use of AR for educational activities led to a successful proposal funded by EIT Digital, Europe's largest digital innovation community. Out of the EIT project, a spin out company was formed (EdAR). EdAR is a start-up company in the Digital Industry specialising in developing educational augmented reality applications for higher education.
EdAR aims to be a world-class start-up helping educators integrate high-quality AR content into their teaching, making learning more intuitive by superimposing 3D holograms and explanations onto the physical world [1]. EdAR is following an academic 'textbook' model whereby high-quality AR content is developed with world-leading experts from respectable organisations, such as University of Edinburgh, University of Minho, Babcock, DTx Colab and Theorem Solutions.
The AR content is then accessed via a subscription to the customers, who can easily integrate the AR content into their teaching via an AR headset, mobile or tablet device [2].

What have been the benefits to student learning?

The distinctive technological characteristics of mobile learning deliver positive pedagogical affordances. Klopfer and Squire [3] mention that the most frequently reported characteristics of mobile learning are “portability, social interactivity, context, and individuality” with portability as the most distinctive feature that automatically sets apart mobile learning from other learning methods [3] [4]. These positive pedagogical characteristics are further enhanced by the use of augmented reality which gives the learners flexibility and makes complex spatial concepts more understandable.

In an effort to collect insights regarding the use of AR for educational activities we run a workshop. The cohort consisted of 19 undergraduate medical students, three Postgraduate trainees and two Junior trainers (non - consultant) who demoed the Pelvis Experience using our 3D printed models.

Figure 5 Participants demoing the Anatomy Experience.

The participants were asked if they used augmented reality (AR) in the past. The majority of participants (16) never used AR in the past while 8 had.

In the question “Do you agree that the EdAR application can enrich the learning process?”, 20 (83.33%) of the participants answered that they strongly agree with the statement and four (16.67%) answered that they agree with the statement.

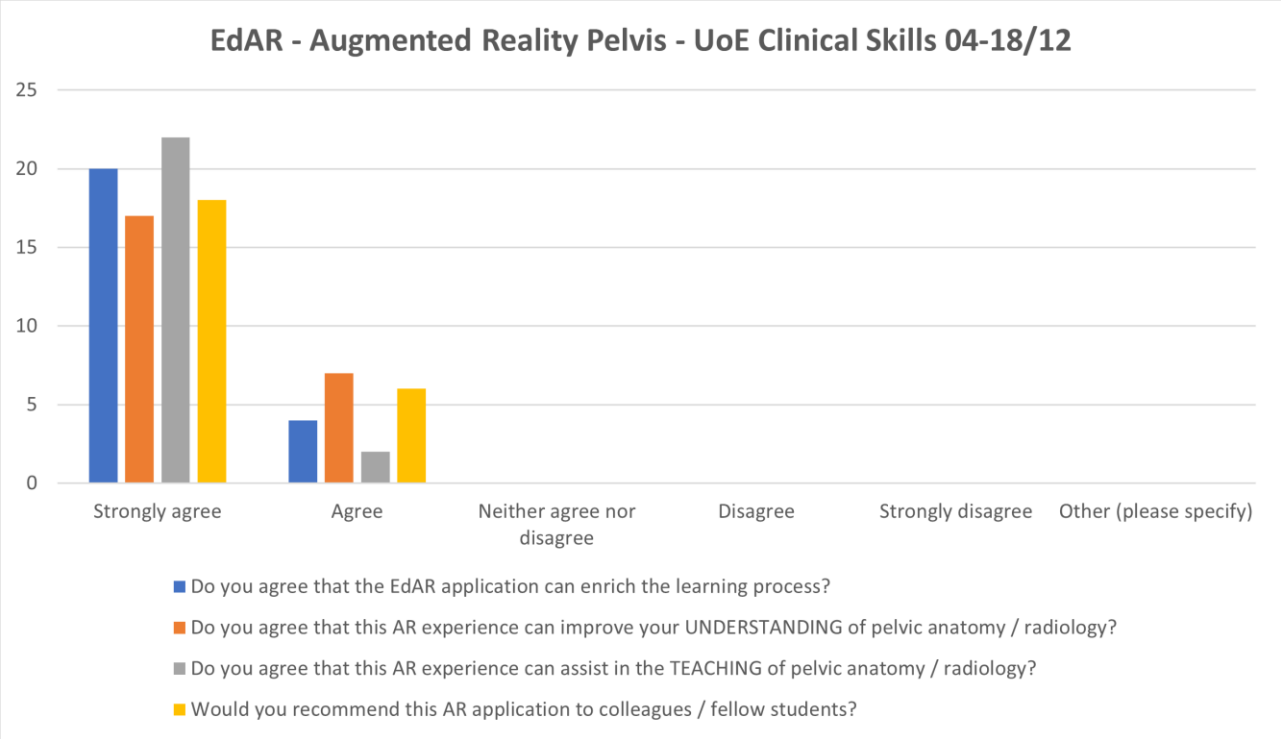


Figure 6 Questionnaire answers

Participants were asked to give additional comments on the Pelvis Experience, some of which are given bellow.

“Has a lot of potential for learning the anatomy of complex 3D structures, given then the majority of current teaching mediums are 2 dimensional.”

“Very helpful technology for mentally mapping position of a 3D object in a 2D plane. Easy to see the applications and benefits for CT scan interpretation and even for pre-operative planning if the technology can create a 3D model of the patient's anatomy to be looked at pre-op.”

“I think the scope for this to be used in medical education is very wide, and the ease of use is excellent. The ability to use this for trainees to better understand radiological findings is vast. I would also consider that the ability to use this, alongside anatomical dissections could help with a lot of clarification for students learning their anatomy.”

“Very useful system, with huge scope. Could also be very useful for patient information in consent. Also useful in considering intra-operative prosthesis placement and design.”

“This will help me understand complex 3D relations relevant to hip surgery.”

“Very interesting for future anatomy teaching.”

"Would be really helpful in putting anatomy into practice."

How could these benefits be extended to other parts of the university?
This project led to collaborations with EdAR developing AR educational material for many Schools within the University of Edinburgh and other academic institutions. Active projects include an Ecology Experience that acts as a virtual lab, an Anatomy Experience which helps teach medical students, complex parts of human anatomy and how to better understand medical imaging, an Engineering Experience regarding beam deflexion and others.

References

[1] A. Sherlock, A. Cunha, A. Pontes, M. Stowe and N. Lines, EdAR start-up proposal, 2019.
[2] A. Sherlock and A. Cunha, EdAR May company meeting, 2020.
[3] Klopfer, E., Squire, K., 2008. Environmental detectives-the development of an augmented reality platform for environmental simulations. Educ. Technol. Res. Dev. 56, 203–228. https://doi.org/10.1007/s11423-007-9037-6
[4] Park, Y., 2011. A pedagogical framework for mobile learning: Categorizing educational applica-tions of mobile technologies into four types. Int. Rev. Res. Open Distance Learn. 12, 78–102. https://doi.org/10.3394/0380-1330(2006)32

Financial statement (please delete as appropriate):

Either
This project has utilised the funding awarded to it by the PTAS adjudication committee and the Principal Investigator or School Administrator appropriate can provide financial statements showing the funding usage as and when required by the UoE Development Trusts who may require it for auditing purposes.

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