The Augmented Library: Motivating STEM Students

Dr Mike Hobbs (mike.hobbs@anglia.ac.uk)
Faculty of Science and Technology

Dr Debbie Holley (debbie.holley@anglia.ac.uk)
Faculty of Health, Social Care and Education

Chloe Menown (chloe.menown@anglia.ac.uk)
University Library

Abstract

A review of first year Computing and Gaming Technology (CGT) students undertaking Personal Development Planning (PDP) as part of a key year one module showed a lack of engagement (and submission of work). Research shows STEM students traditionally spend little time in formal library settings, and thus lack knowledge of the process of research. This work is focused on encouraging students' transition from their online 'persona' in multiple contexts to 'becoming' a student. Taking a radically different approach to the sessions, the students, in small groups, were tasked with co-creating library artefacts through the medium of Augmented Reality (AR). Weekly classes were 'flipped' and used for feedback, discussion, and exposure to research in action, where they became part of, and embodied within the research process. Our findings show significant and enhanced engagement with the learning process, and higher coursework submission rates.

Introduction

Problems with PDP

The motivation for this work was to energise the weekly one-hour Personal Development Portfolio (PDP) sessions, included as part of the first year module *Computing and Gaming Technology (CGT)*, and delivering basic academic skills and orientation to our University procedures. The traditional format relied on documents, which were used for discussion in class, but were not associated with any practical sessions. Student feedback and review by the staff indicated that the students did not value the PDP element. This resonated with research that indicates a lack of employability and soft skills in recent STEM (Science, Technology, Engineering, and Mathematics) subject graduates (CBI/Pearson, 2013), (Harris, 2014), (UKCES, 2014).

Brown *et al.* (2008) had successfully used the virtual world, *Second Life*, as a focus for developing group work. We hoped, therefore, that by introducing a small project, the CGT students would gain experience in skills such as group work, time planning, report writing, presentation, literature research, academic referencing and critical reflection.

The assessment for the whole PDP section is 'pass / fail' and the only requirement is that students show 'engagement' (as judged by the tutor) with the topics. The advantage is that the topics are not assessed for content as showing engagement is the means to a pass/fail mark, allowing the students to engage with the topics without the fear of their project work being assessed. The disadvantage is that the workload assigned to the PDP project had to be very light as the PDP section is a small element of the overall module grade.

Augmented Reality in Education

Augmented Reality (AR) has been used in education as a way of presenting content in a novel context (Yuen, 2011). Wu *et al.* (2013) provide an overview of the features and affordances of AR:

> 'enhanced learning experiences by using 3D synthetic objects for students to interact with… A pervasive or mobile-AR system could enable ubiquitous, collaborative and situated learning enhanced by computer simulations, games, models, and virtual objects in real environments… AR and other immersive media for learning such as serious games and virtual worlds offer affordances of presence, immediacy, and immersion… Superimposing virtual objects or information onto physical objects or environments enables visualization of invisible concepts or events… AR has the potential to bridge the gap between learning in formal and informal settings' (2013; pp. 43-44).

A typical augmented reality scenario is to link media (image/video/audio) to a real world object, viewed through the camera of a mobile device. The media is then 'triggered' to play by the object it has been attached to. The trigger occurs when the AR software recognises the object through the device camera and overlays the media onto the trigger image, thus creating an augmented image when viewed through the device. A good example is the *HeartCam* app (Mechanism Digital, 2015), which uses a stylised heart image to trigger a realistic animation of a real beating heart in the chest cavity. Our view is that while there are advantages to locating media triggers in the real world, students will gain more benefit from the 'experiential learning' (Kolb & Fry, 1975) opportunity to develop their own materials.

The research with the CGT students has been enhanced by the team delivering AR workshops in different learning contexts (see Hobbs and Holley (2015) Augmented@ARU, which also has instructions for getting started with Aurasma and links to other materials). For example; a group of 55 visiting teachers of English were supported in accessing broader vocabulary through AR and an Anglia Ruskin schools project is using AR as a mechanism to unpack strategies for supporting good classroom behaviours as part of a series of CPD workshops.

The PDP AR Mini Project

Students were introduced to the *Aurasma* AR creation app (http://www.aurasma.com/), which was presented to them as the core technology to be used in a 'mini' project. The students self-selected into small groups of between three and five members, and groups were asked to create a name and logo, and to engage with the University Library, in the broadest sense, by producing an AR aura. An aura being the finished product of an image triggering an image/video/audio on the device screen. One or more students in each group downloaded the *Aurasma* app onto their smart phone or tablet device and together they had to learn how to use it to create their auras.

The students were encouraged to plan, script and storyboard their aura. Apart from asking them to observe the intellectual property rights of images, videos and music, students were free to create their own media. Supporting materials and 'how to' instructions were used to help scaffold and posted on the Virtual Learning Environment (VLE). The weekly sessions were 'flipped', rather than a taught session they were used for feedback, demonstrations, discussion and to guide the students to the supporting materials. Additional support was

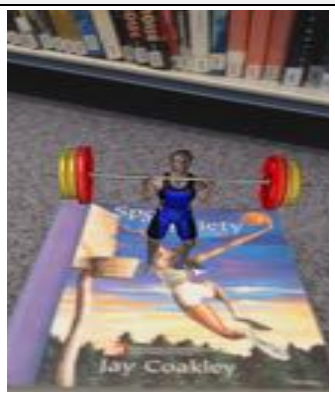
offered through email, VLE discussion boards and comments posted on the blog that students used to report their progress.

The AR project offered a new way of working that created a more engaging programme as the focus for the development of academic skills. Students were introduced to *Aurasma* and, working in groups outside the class, they created team logos and worked on creating their auras. Students used the AR project as a focus for research, referencing, group work, report writing, presentations and blogging on the VLE.

Dr Debbie Holley conducted interviews with forty of the students, drawn from three seminar groups self-selected for video interviews in the class. The seminar tutors videoed the session, offering the whole cohort insights into the research process being modelled in the class through the project team. This activity was explained in detail to the students so that they were engaged in the research process as well as being participants. We sought to use this project as a case study for the students to develop their own practice and reflect on the progression from a passive to a more active view of their role as students.

Results from the Students Engagement with the AR Task

A selection of the auras created by the students have been analysed in table 1 for their applicability in a wide context within the library and the learning process behind the auras.

Group	Aura created	Applicability and supporting literature
Quack Attack ‘Sports in Society’ Book with weightlifting aura		This group provided a quick summary of the book topic. This helps readers to focus on the relevant text and provides a scaffold for the learners’ cognitive processing. (Leopold, Sumfleth & Leutner, 2013). This could aid those who cannot read very well or lack a sufficient attention span.
Button Bashers Aura of Disney characters over course book		This is a fun animation which engages people with the book further. Hartel (2014) suggests that educators and students would benefit from a playful approach to information.

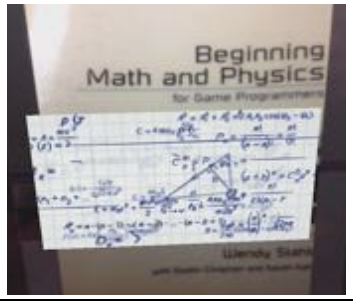
Blaze Video clip of student talking about the book		This is useful for students to get a first-hand opinion on the book; Chan (2008) found that consumers' buying habits are affected by the reviews they read from other consumers. This is especially effective for new products with few reviews (Hu, Liu & Zhang, 2008).
Nukeln Aura of mathematical calculations on book cover and a diagram on a page		This group chose to overlay maths equations to a book, the aura was triggered by a related diagram which required a maths equation to understand. Information can be retained easier through AR than non-AR (Sommerauer & Müller, 2014).
Indoor House Cat Logo triggers an image of the group participants		By triggering an image as the overlay you can display more detail as images have the potential 'to encode large amounts of information' (Ridley & Rogers, 2010) such as a picture of the author or their Subject Librarian.
Red Squadron 1 Room numbers trigger 'this way' arrows to the library		This could be very effective for students who find the numbering system in the library complicated, as pictures support understanding complex concepts (Eitel *et al.*, 2013). This could also work to help new students find the library in induction week and the AR signs would not affect the aesthetic look of our University.
EBO Aura over course-related book		The overlay is a title page of the book – chosen for its amusing style. This would give a reader an idea of that the book had a light hearted side as well as being a technical text book. By displaying a preview page of the book this group gave a summary which helps learners to understand the content of the book. (Leopold, Sumfleth & Leutner, 2013).

Table 1: Group Auras

Discussion and Theoretical Perspective

The students displayed a wide range of interpretations of the Library for the AR project. The *Red Squadron 1* group, for example, defined the Library by its physical space, while the *Quack Attack* group defined it by the content it contained. Both approaches are supported by literature as they provide learners with further understanding through the use of images (Eitel *et al.*, 2013). There is further evidence from Sommerauer & Müller (2014) that augmented reality actually improves learner's memory; they studied museum visitors attending an exhibition with a mixture of AR and non-AR exhibits and found that visitors retained the information better when it was presented to them through AR. This supports the use of a maths equation by the *NukeIn* group as an aura trigger for a related equation. Helping users to understand the concept by supporting their cognitive processing through imagery (Ridley & Rogers, 2010), and giving them a better chance at retaining the information (Sommerauer & Müller, 2014).

The students in the *Blaze* group chose to use the aura to review a book through a triggered video. This approach fits with Chan's (2008) notion that people's opinions of a product are influenced by their peer's reviews. The *Blaze* group's approach could, for example, be extended to create review auras for books in the Library. The students have shown high quality engagement with how to interact with the Library and provided a range of useful AR ideas to promote the services offered.

An interesting observation about this project as a whole, is that rather than focusing on perfecting the application of technology to create an immersive and engaging experience within the virtual world, this project has used the virtual to bring students to engage with the real world. Students experienced finding and using physical books in the real library as an alternative to their usual habit of searching online for information and resources (Sadeh, 2007). In doing so this may have given them a deeper perspective on accessing knowledge though physical media within the context of a dedicated, immersive and engaging study space.

Results of the Success Rates from the PDP project

The PDP element is a small part of the core Computer Gaming Technologies module and most of the student time is focused on the lectures, classes and assessments for the main part of the module.Although students are aware that they have to pass the PDP element to pass the whole module, some students who made an attempt at the much larger and more difficult main assessment failed to submit work for the smaller and less challenging PDP element. Table 2 shows the rates of non-submission of the CGT assessment elements.

Academic Year	Cohort Size	Main Assessment		PDP Assessment	
		n	%	n	%
2013/14	55	11	20.0	19	34.5
2014/15	78	18	23.1	17	21.8

Table 2: Non-submission of Assessment Elements

As Table 2 shows, in the 2013/14 academic year, eight students who completed the main assessment did not submit the PDP element. In the 2014/15 academic year, however, one more student submitted the PDP element than submitted the main assessment.

Proportionately, while there was a moderate increase in student failure to submit the main assessment, the fail-rate for submission for the PDP element decreased by 12.7%.

Evaluation

The Non-Submission of Assessment Elements data shows an increase in student numbers from 2013/14 to 2014/15 and also an increase in Non-submissions for the main assessment. It is unsurprising that the non-submissions for the main assessment increased as the number of students in the module has grown from 55 to 78. Logically the number of Non-submissions will increase as the percentage is maintained at 20% of the cohort size.

However, the growth in cohort size has not affected the non-submission rate for the PDP assessments, the overall number has dropped significantly from 19 to 17 students not submitting their PDP project. The remarkable reduction of 12.7% in non-submission of PDP project has been attributed to the use of Augmented Reality within the module to engage the students with the assessment.

As further evidence for the success of the PDP project, one more student submitted their PDP assessment than did the main assessment.

Conclusions

In conclusion, the non-submission rate for the PDP project decreased by 12.7% after engaging with the AR element of the project. The students expressed the usefulness of this task and how working in small groups on their auras provided them with the opportunity to develop their communication skills and group working skills (Button Bashers 2015)). The concept of the PDP project was alien to these students who are not used to working in this manner on their course. The technology is a useful medium to promote discussion, enhance skills and support learning in areas of the curriculum Meyer and Land (2005) would term 'troublesome knowledge' – enabling learners to access these areas through working in small groups and creating an aura together, thus encouraging user-generated content (Krumm *et al.*, 2008) – a far more powerful learning experience, we would argue, than traditional didactic methods.

This method of engagement is not limited to technology students, Aurasma is an Augmented Reality app that is easy to use and can be quickly learned by a range of students. The team have delivered workshops based on this research project with a range of academics and students. These teaching materials and workshop reports are available on the project blog site (Augmented@ARU 2015). There are implications beyond the classroom for this project, Augmented Reality can be used by a wider sector to encourage student engagement with the service.

Acknowledgements

This project is a joint venture between the University Library, the Department of Education and the Department of Computing and Technology. We would like to thank Anglia Learning and Teaching for funding this work.

References

Aurasma software, [Online] Available at: http://www.aurasma.com/ [Accessed 21 August 2015].

Augmented@ARU, 2015. Blog and Resource site for Anglia Ruskin Augmented Reality Framework Project. [Online] Available at <http://augmentedaru.org>

Brown, E., Hobbs, M., and Gordon, M., 2008. A Virtual World Environment for Group Work. *International Journal of Web-Based Learning and Teaching Technologies*, Vol. 3, No. 1, pp. 1-12.

Button Bashers, 2015. Button Bashers PDP Group Blog posting. [Online] Available at: < http://vle.anglia.ac.uk/sites/cat_dept/PDP_CGT_2014/ButtonBashers_PDP_CGT_2014%20Students/default.aspx> [Accessed August 2015]

CBI/Pearson, 2013. *Changing the pace: CBI/Pearson education and skills survey 2013*. [Online] Available at: http://www.cbi.org.uk/media/2119176/education_and_skills_survey_2013.pdf [Accessed 11 August 2015].

Chan, Y., 2008. Herd behaviour in purchasing books online. *Computers in human Behaviour*, Vol. 24, No. 5, pp. 1977-1992.

Eitel, A., Scheiter, K., Schüler, A., Nyström, M. and Holmqvist, K., 2013. How a picture facilitates the process of learning from text: Evidence for scaffolding. *Learning and Instruction*, Vol. 28, pp. 48-63.

Harris, M., 2014. Graduate Careers: The STEM shortage paradox. *Physics World*, October 2014. [Online] Available at: http://live.iop-pp01.agh.sleek.net/2014/09/25/the-stem-shortage-paradox/ [Accessed 11 August 2015].

Hartel, J., 2014. Drawing information in the classroom. *Journal of Education for Library and Information Science*, Vol. 55, No. 1, pp. 83-85. [Online] Available at: http://works.bepress.com/cgi/viewcontent.cgi?article=1037&context=jenna_hartel [Accessed 11 August 2015].

Hobbs, M. and Holley, D., 2015. Augmented@ARU: Augmented Reality Framework for Anglia Ruskin University (WordPress Blog). [Online] Available at: http://augmentedaru.org [Accessed 10 June 2015].

Hu, N., Liu, L. and Zhang, J. J., 2008. Do online reviews affect product sales? The role of reviewer characteristics and temporal effects*, Information Technology and Management*, Vol. 9, No. 3, pp. 201-214.

Kolb. D. A. and Fry, R., 1975. Toward an applied theory of experiential learning, in C. Cooper (Ed.), Theories of Group Process. London: John Wiley.

Krumm, J., Davies, N., and Narayanaswami, C., 2008. User generated content. *Pervasive Computing, IEEE*, Vol. 7, No. 4, pp. 10-11.

Leopold, C., Sumfleth, E. and Leutner, D., 2013. Learning with summaries: Effects of representation mode and type of learning activity on comprehension and transfer. *Learning and Instruction*, Vol. 27, pp. 40-49.

Mayer, R. E., 2009. *Multimedia Learning (2nd Edition)*, Cambridge: Cambridge University Press.

Mechanism Digital, 2015. *HeartCam App*. [Online] Available at: http://mechanismdigital.com/#non-broadcast/pharma/HeartCam [Accessed June 2015].

Meyer, J. H. F., and Land, R., 2005. Threshold concepts and troublesome knowledge (2): Epistemological considerations and a conceptual framework for teaching and learning. *Higher Education*, Vol. 49, No. 3, pp. 373-388.

Ridley, P. and Rogers, A., 2010. *Drawing to Learn: Science, Technology, Engineering and Maths – Visual Learning in Higher Education*. University of Brighton: Centre for Learning and Teaching. [Online] Available at: http://about.brighton.ac.uk/visuallearning/drawing [Accessed June 2015].

Sadeh, T. 2007, "Time for a change: new approaches for a new generation of library users", New Library World, vol. 108, no. 7, pp. 307-316.

Sommerauer, P. and Müller, O., 2014. Augmented reality in informal learning environments: A field experiment in a mathematics exhibition. *Computers & Education*, Vol. 79, pp. 59-68.

UK Commission for Employment and Skills (UKCES), 2014. *The Labour Market Story: Skills for the Future: Briefing Paper 2014*. [Online] Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/344441/The_Labour_Market_Story-_Skills_for_the_Future.pdf [Accessed 10 May 2015]

Wu, H., Wen-Yu Lee, S., Chang, H. and Liang, J., 2013. Current status, opportunities and challenges of augmented reality in education. *Computers & Education*, Vol. 62, pp. 41-49.

Yuen, S., Yaoyuneyong, G., and Johnson, E., 2011. Augmented reality: An overview and five directions for AR in education. *Journal of Educational Technology Development and Exchange*, Vol. 4, No. 1, pp. 119-140. [Online] Available at: http://www.sicet.org/journals/jetde/jetde11/11-10-steve.pdf [Accessed 11 August 2015].