FINAL REPORT

Loughborough University Teaching Innovation Awards

Name(s)	School(s)/Department(s)
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Project title

Virtual Reality in STEM teaching

N.B. Expand the text boxes as necessary. It is perfectly acceptable to use bullet pointed lists of outcomes, issues, activities, etc. if preferred

Abstract (200-250 words)

Our project was to test the concept of using virtual reality as a method of prelab learning, our student developer has created a virtual reality application based on the STEMLab environment with a Chemistry experiment for students to virtually complete. The student developer was at the end of his MSc degree and developed the virtual application for us based on the Chemistry experiment 'Absorbtion Spectrophotometry'. The application featured 3 rooms:
1.Familiarisation- including putting on a lab coat
2.The experiment- where they carried out the steps as they would in the lab
3.Advanced molecular room- Large interactive molecule structures that students could move around to look for the line of symmetry.
To move to the next room you must have completed the tasks in the room you are in correctly, encouraging students to really understand what they are doing in order to move to the next stage.
We held two lots of testing for the application with students and in total had 20 student tester use the application. We also tested with a group of Chemistry staff too receiving very positive feedback. As this project was in its final stages we have since won a further Teaching Innovation Award to roll this application out further to other subjects and to transfer its use into the Igloo.

Issue(s) addressed by project

Currently the first time a student sees a piece of laboratory equipment, instrument or apparatus is when they enter the practical lab session to use it. For the students, this means there is often time spent getting to grips with basic instrument functions, meaning less time using the equipment effectively and optimising their results. In this situation, surface learning often occurs as students will be focused on the procedure of using the instrument rather than the wider picture of what the results mean in relation to their programme of study. Whilst concentrating on how the instrument works, students can often overlook the purpose of the experiment and struggle to observe/infer fully to properly interpret and critically analyse their outcomes. Lab based skills require practise and repeated viewing to properly achieve the subject specific skills-based ILOs, therefore our proposal is the use of virtual reality labs to complement our practical sessions to offer new and innovative ways of learning science that students can access without physical, or health & safety restrictions (Clark 2006).

Aims

•Encourage deep learning within lab-based teaching
•Allow more focused time for exploration of the experiments without being at risk to themselves or others
•Increase students awareness of the equipment available to them in the labs

Specific objectives

•Create an interactive resource that allows for practice, familiarisation and visualisation before students enter a lab session.

•Increase student engagement in the module by encouraging them to see beyond the procedural aspects of an experiment.
•Evaluate the tool's impact on student learning and ability to be transferable.

Activities/methodology

1. Appointed a Computer Science student developer – MSc student Nicolas Demosthenous
2. Established a story board of the experiment and the actions the students needed to make to complete the experiment from Academic Sandie Dann
3. Received content and advice from Technical Tutor Rod Dring
4. Student developer worked from September-November developing the application
5. Held staff testing of the application with Chemistry Academics and Technical Tutors
6. Held student testing of the application. The first test involved 8 students that responded to an advert completing a pre-test survey, doing the application then completing the exact same experiment in the Lab and then completing a post-test survey (ethical approval gathered).
7. Held second student testing to gain more participants, this time only a pre and post survey and the use of the application, i.e. without completion of the experiment in the lab,12 students took part (ethical approval gathered).
8. Collate findings into short summary paper to share with colleagues and build into next Teaching Innovation Award.

Project outcomes/findings

The team found that in all their discussions about VR in the project with staff and students that the general attitude to the project and idea was very positive and excited at the prospect of the technology. On testing the application after they had used it the staff had lots of ideas about where the technology could be used elsewhere for example in inorganic chemistry in relation to all the glassware and set up. The most informative feedback was from our students (20 student testers) who were overall very excited about the possibility of seeing this technology go further in their learning.
Attached are the summary of results but the headlines include:

•**80% of the participants saying that they would like to see it used in their modules**

•**11 had an increase in confidence** in recording a good quality UV spectrum (the Chemistry experiment)

•All **20 participants** when asked 'How well did you understand the experiment?' after using the VR rated between ***moderately well understood*** **to** ***extremely well understood***.

•In the second test where questions had been tweaked slightly **11/12 rated that they recalled 'the majority of the instructions'- 'enough to complete the experiment confidently'** with **5 giving the top rating** 'enough to complete the experiment confidently'.

•In the second test where students were asked 'On a scale of 1 to 5 *(1 being not at all, 5 being improved my learning)* do you think the virtual reality environment could improve your learning?' **All 12 students rated 3 or above** in improving their learning and **9 of the students rated either 4 or 5.**

•In the second test in regard to specific Chemistry questions the students were asked 'Are you familiar with the concept of the subtractive colour model and how it relates to colour?' **8 reported a rise in familiarity after using the virtual reality.**

•Again, in the second test a Chemistry related question 'How familiar are you with the concept that different sorts of compound exhibit varying strengths of colour transition?' Pleasingly **7 out of the 12 respondents said they were very familiar or extremely familiar with the concept** in the post survey in comparison **to 4 out of the 12 respondents in the comparative pre-survey** before the VR.

Qualitative comment highlights:

'Improved familiarity of lab environment and process so that you could focus more on what was actually happening in the experiment therefore you could learn more about the chemistry occurring'

'It was different and engaging, I did actually learn things too'

'Better preparation before actually doing the lab'

'Engaged me and made me focus on what was going on and the novelty of the experience helped me to remember what happened in the VR environment. The fact that the VR experience didn't let you continue until the experiment was performed correctly helped to analyse and reflect on any actions.'

Project outputs/deliverables

•Fully working virtual reality application containing a familiarisation room, a Chemistry (UV/Visible Absorbance Spectroscopy) experiment and the final room the 'molecular room' demonstrating the atom structures and the theory related to the experiment the students have just completed.
•Positive student feedback and appetite for virtual reality in their teaching
•Interested colleagues that want to try it in their modules- new TIA applicants
•As a result of the project we now also have 360 imagery of STEMLab and equipment that can be used in a virtual reality environment and other sorts of online environments.
•We feel that we have also delivered on our original hoped output 'A new evaluated approach to Lab teaching that could be applied in other areas' by testing knowledge pre and post VR use it is clear confidence and learning can be improved in the use of this technology.

Impact on teaching and learning (for your students, your School and including links to University strategy) [*This will be the longest and most significant section*]

<u>The impact for our students</u>

The results from our initial studies show great potential for this technology and way of learning. So many of the students commented themselves that this would be a great way to learn and practise an experiment before they do it and to remind themselves of it in the weeks afterwards. The students themselves also noted the ability this technology has in highlighting the dangers of lab work and could allow them to use it to see things they can't see in the lab which is where our next TIA will take us. The obvious increase in confidence and knowledge within their answers in the post survey was a great indicator that this technology can in fact help them to learn. Many of them also mentioned the impact the gamification side to the application that meant they had to learn how to do something to get to the next stage. In regards, to our observations of the behaviour use of a virtual reality application itself we felt it was very interesting that the students were able to memorise where objects where and remember the exact location of instruments after they had finished using the application. We felt this could be very useful to investigate further for its benefit in lab-based subjects.

<u>The impact for the School</u>

The School is benefiting hugely from the project in that the students will gain more if this application is launched within the next TIA and their profile is also being raised. This project has highlighted to staff in the School that innovation in your teaching is possible, however outlandish it may first appear and has generated a lot of interest from colleagues. So much so that in the upcoming TIA we are working with not only Chemistry again but Physics and Biology in addition to Materials. The impact on incoming students is great as we get further into development the more they will benefit, and it should also attract students to student STEM at Loughborough too.

<u>Links to University strategy</u>
We stand by the links we made in our application a year ago, but we also feel completely aligned to the more recent **Digital Strategy**. The student testing was often the first-time students had used VR which was surprising, but we feel this sort of project and roll out would be aligned to the strand of the strategy around Digital Fluency in our staff and students more than ever.
Educating for success
The aim of this project is to transform the laboratory teaching experience for our students by encouraging deep learning and improving understanding of the experimental area of their degree and improving user confidence.
Raising Standards and Aspirations

Increasing the standard of STEMlab provision by adding a virtual layer of interactive resources that support the physical lab space and the sector leading facilities.
Growing capacity and influence
This project would be of great interest not only to others in the sector but to external groups for example: Jisc, Times Higher Education and the Association for Learning Technology.

The future

The next stage is thinking carefully about how to make it available to students on a wider scale, it is too big of a workload to make a VR activity for every module in Chemistry let alone the rest of STEM so we need to think carefully about where it is best placed to give the best benefits to students and how to achieve that. Our vision is that we will one day develop a front-end application that a staff member can select the instruments or objects involved in their module and put them into an engine that generates the activity for them however this will take a great deal of time or resource into paying a developer. In the meantime, we are focussing on how to make sure what we put into the VR is for the benefit of the students, so it is adding to their learning but also is something that you couldn't do in any other environment other than VR to truly get the benefit.

Dissemination plans including location of developed resources for Loughborough colleagues to access (resources can be attached to this document or linked to – in which case please provide an accessible location of resources)

We hope that the Loughborough Learning and Teaching conference will be a great platform to share our work with colleagues not only in the session we have been allocated but also in the Technology Showcase. We would like to demonstrate the application to as many people as possible to show them what is achievable even with just one student developer over a short period in order to encourage them to 'think big' about what is possible.
Our subsequent Teaching Innovation Award aims to take the products of this TIA forwards, now that we have proven the concept of VR in STEM teaching is worthwhile we can look to develop ideas for further disciplines
We have also identified a VR in Higher Education conference that we are hoping to present at to disseminate externally and to learn more for Loughborough.

Use of award money (outline breakdown)

Budget = £4970.50

Student developer: £2790
Student testers: £405
Samsung S8 x 2: £1324.78
Samsung Gear Headset and Controller x 2: £238
Poster Printing (L & T conference): £22
Unity Assets: £190

Please submit the completed documentation by **30 April 2018** to:

Deena Ingham, *Teaching Innovation Awards Panel*
Centre for Academic Practice

cap@lboro.ac.uk