Case Study Title: A systems approach to unlocking student potential and the hidden curriculum.

Organisation: School of Microbiology, University College Cork

Background:

Experiential and Immersive learning approaches have significant potential to transform the student experience when engaging with challenging molecular and cellular concepts in life science education. Experiential learning approaches can instil deeper learning of how molecular biology can be applied to address real-life societal challenges. Group learning, applied performances of understanding, cross-disciplinary international collaborations, and offering multiple modes of expression are just some of the ways we strive to connect the hidden curriculum. In tandem with this, immersive virtual reality and 360 degree simulations offer innovative entry points for student learning where spatial understanding can unlock a deeper engagement with molecular concepts.

Aims:

We sought to take a systems approach to student engagement that aligned intervention sequencing with specific stages of their higher education journey and the accompanying learner challenges/needs. While there have been many wonderful initiatives undertaken to support the student journey, these have typically either been designed as stage-specific interventions or as inclusive-driven alterations to conventional teaching practices. To achieve a truly inclusive learning experience, access to and performance of knowledge and understanding should be universal by design. Here we present a roadmap for biological sciences as students transition in, through, and out of higher education (**Figure 1**).

Figure 1. Transition in phase: Virtual Reality simulations developed where students can take an immersive, multilingual journal through the human and bacterial cell, learning about the structure and organisation in their own time, at their own pace, and in their own language. 3D printed models support this learning experience, providing a tactile interactive device for students. Transition through phase: Students in second year Biological Sciences work on applied problems, faced with 'why fund my research' questions in a group environment, an assessment for learning. Through Community Engaged Learning in 3rd year students tackle the UN SDG Challenges, applying their knowledge to societal challenges. They learn about molecular biology and genetic engineering through bespoke virtual reality simulations designed through the ELEVATE initiative at UCC, performing their understanding through a group project using a bespoke Molecular Canvas designed to represent an industrial pipeline for recombinant protein technology. Students also work on an Antibiotics Unearthed initiative, working in groups to present posters to faculty and peers. Transition out: In final year, students work through bespoke 360 simulations designed to replicate real life scenarios and workplace situations, also engaging in an international collaboration with students from Mexico to build a PR campaigns around a biotechnology product.

Implementation:

A cornerstone upon which the final framework was built centred around the National Forum sponsored ELEVATE initiative (https://www.teachingandlearning.ie/project/enhanced-active-learning-in-virology-cell-culture-and-molecular-biotechnology-elevate/) which developed multilingual digital tools for student visualisation and conceptual immersion in Cell Culture and Molecular Biotechnology (**Figure 2**), enabling deeper engagement with, and understanding of, challenging curriculum (https://www.frontiersin.org/articles/10.3389/frvir.2021.670909/full). Student engagement in shaping the virtual reality simulations was key, partnership with them in each step of the development and implementation journey (https://pubmed.ncbi.nlm.nih.gov/35671125/) leading to recognition through the Disciplinary Excellence in Learning, Teaching and Assessment (DELTA) from the National Forum (https://www.teachingandlearning.ie/2021/05/25/teams-from-mtu-ucc-and-ul-receive-delta-awards/). Learning is student paced, assessment built into the simulations is formative in its application, with the key concepts then applied in an applied summative assessment through the bespoke Molecular Canvas group project (https://www.youtube.com/watch?v=BnyrZiIKhNw). Here technology guides the learning journey, but the student voice performs the understanding. Scalability of assessment is delivered through the web-based platform enabling real time access and re-takes as part of the learning process.

We then explored the application of virtual reality simulations in second level education, providing an immersive visual experience of the human and bacterial cells for students using our multilingual platform. This SSPC SFI Centre for Pharmaceuticals sponsored initiative is at pilot phase across 10 schools and work is ongoing in partnership with teachers to expand the application of these learning technologies across the school network.

'Antibiotics Unearthed' was inspired by the Small World Initiative™. The School of Microbiology, UCC was chosen as one of the six original participants of this project, which lives on in UCC as a part of the 10-credit Module MB3016 Methods in Microbiology (https://www.ucc.ie/en/microbiology/microbiologyatuccnewsletters/antibiotics-unearthed-and-best-poster-2022-23.html). Students experience genuine research with real world significance, hoping to find the next new antibiotic from soil, familiarising themselves with a professional environment and engaging with research microbiologists. Teamwork, peer learning and performative learning through large audience presentations of scientific results promote lifelong skills and broader graduate competencies through the students' varied experiences while participating in the project.

In the Community Engaged Learning project, linked to the societal challenges posed by the UN Sustainable Development Goals, students work with community partners on a programme of research and interpretation that builds on the skills and knowledge acquired in their course. This fosters a real sense of purpose in the students and linking it to assessment is an important dimension, crediting students in a real sense for their engagement and critical interpretations of the real-life research outcomes.

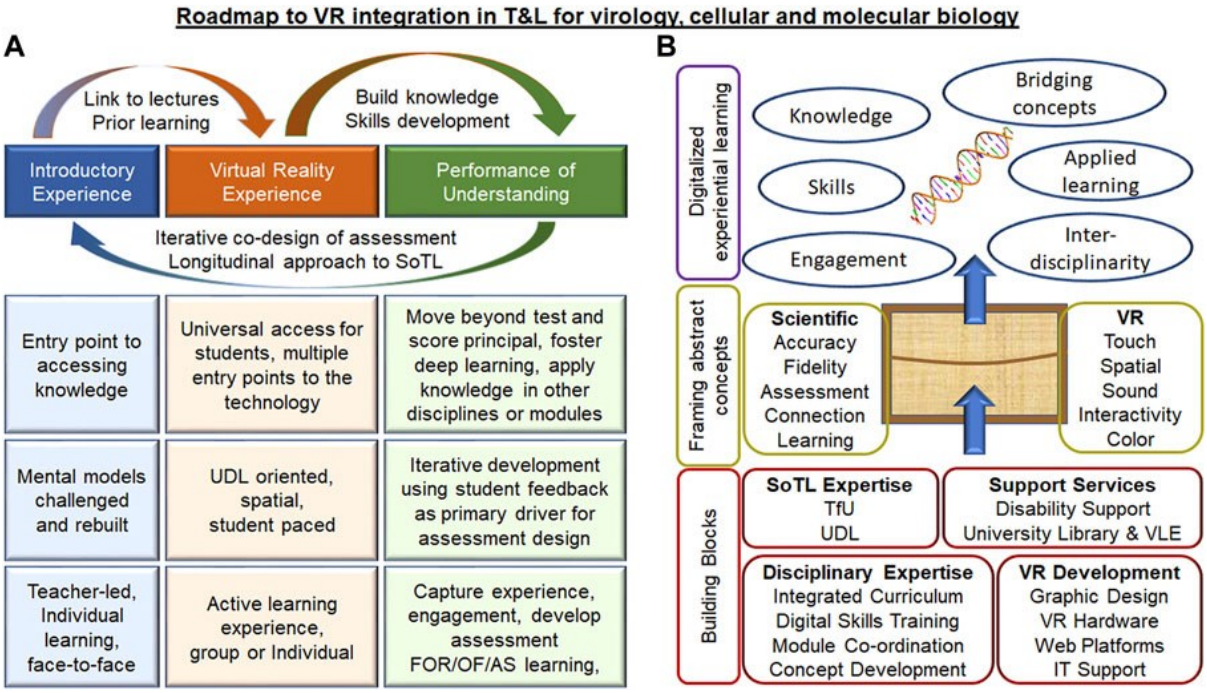

Figure 2. Overview of the key considerations underpinning the effective integration and implementation of immersive learning technologies in teaching and learning of challenging molecular concepts. 1) Modular roadmap bridging the introductory experience with a performance of understanding, whereby a VR experience acts as a throughline upon which to scaffold the overall learning experience. 2) The collaborative expertise required to successfully design and integrate a VR experience within modular content highlights the true potential of this multi-disciplinary approach to T&L in higher education.

In their final year of study, students engage in a range of bespoke 360 degree virtual simulations, contextualising their learning in real life scenarios, linking assessment with learning in a meaningful way. This can serve to (i) situate students in a context that gives meaning to their theory and concepts and (ii) enable visual learners to grasp concepts and ideas that can be out of reach when presented in the one dimensional screen. The international aspect of their learning experience, working with students from Mexico to build a PR and Marketing campaign allied to their technology-based executive summaries, also builds important mental models for them whereby the global perspective of their disciplinary knowledge may not be universally shared, an important lesson for them to layer on their own learning experience.

Commitment to multiple modes of expression is evident in the transition from formal assessment to 50% continuous assessment across a range of modules. New elements introduced are designed to capture and encourage skills development, enabling students to perform their understanding in ways they are best equipped to do so. Choices to represent their knowledge through imagery or text, verbally or digitally, all open up the learning and assessment experience for our student cohort.

Outcomes:

The integrated nature of the learning journey, guided by the systems approach to learning and assessment has been very well received by students and faculty. This is leading to greater adoption of alternative assessment and teaching methodologies, and a deeper appreciation of the importance of universal design. It also has resulted in assessment of outcomes that matter, real-life performances of understanding, application of knowledge rather than retention of information.

Students have benefited from the introduction of these new learning and assessment modalities, highlighting the interactive and 'learning by doing' elements as highly supportive, and voicing their satisfaction with digital elements being supported by lectures and tutorials. It is important to note that virtual simulations are seen as an additional resource, and not as a replacement for the lecture/tutorial based engagement. Equally, it is important that digital resources and virtual simulations are appropriately scaffolded by the lecture content. It is clear that active learning with visual engagement is favoured by the students in our programmes.

Reflections:

The student partnership element to our digital research has been particularly fruitful in guiding the key elements of the VR simulation design and determining how that is scaffolded by prior knowledge and the lecture experience. While challenges remain in the creation of a clear and effective roadmap for the design and implementation of immersive VR teaching experiences, collaboration between disciplinary and technical experts will see significant developments in this space.

Lest it be viewed as a future already upon us, while students typically have access to laptops and other digital devices, it was surprising to learn that they are less comfortable or experienced in the virtual or gaming worlds, least so in the areas of digital collaboration/content creation and gaming. Notwithstanding that, the digital and immersive VR experiences were considered a strong motivating factor in the study of molecular biology, and were certainly not limited by lack of peer-peer engagement.

The next phase of development for this initiative is to expand the network of modules and programmes using the systems approach described here, adopting the digital and experiential learning and assessment tools described. Improvements in simulation design and module content will provide the main focus for development going forward.