Virtual labs and Teaching 'by Doing'

Supporting Technology Integration in Higher Education

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ABSTRACT

In this article, we explore some of the lessons learned after introducing a new technology-based environment intended to support student learning. By inviting faculty to participate in discussions about the technology, a number of reflections emerged about the specific interests and circumstances of our teachers, and the potential uses for the virtual labs in higher education. We identified certain problems related to the lack of hands-on experiences of active learning available to faculty, particularly in relation to using new technologies in their teaching. In other words, teachers in higher education are being asked to motivate students with active learnig and technology, but rarely get motivated 'by doing' teaching themselves. Based on the use of virtual reality labs for the biosciences, we seek to motivate scientists to explore new technology through their own field of knowledge and research, and identify interesting uses for education and learning in the process.

CCS CONCEPTS

• **Applied computing** → *Interactive learning environments*; *Collaborative learning*.

KEYWORDS

Technology Integration, Virtual labs, Higher Education

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1 INTRODUCTION

Since the beginning of the millennium, technological innovation, and digital technology in particular have become the drivers of growth and societal change [Castells 2000]. In view of these changes, digital innovation and technology is often described as transformative and disruptive [Serdyukov 2017]. However, this has generally not been the case in higher education teaching and learning, where technology use and innovation tend to be superficial and old pedagogic practices persist [Balasubramanian et al. 2009; Lai 2011; Lillejord et al. 2018; Serdyukov 2017]. This is a tendency that has been referred to as 'disappointing', 'slow' and 'an innovation deficit' in higher education [Balasubramanian et al. 2009; Lai 2011; Serdyukov 2017]. To move beyond a superficial integration of technology, researchers and practitioners are calling for a deeper understanding of how students learn in a technology-based environment, supporting new student-centred and pedagogy-driven educational paradigms [Lai 2011; Serdyukov 2017]. In other words, as technology takes centre stage, we need to define the potential of digital technology in relation to 'its capability for supporting a more interactive and communicative process' [Lai 2011] page 1269, in such a way that it is truly 'pedagogically, psychologically, and socially meaningful and effective' [Serdyukov 2017] page 15. In order to support pedagogy-driven approaches, particularly in relation to new technology and digital integration, the lesson from recent literature is that the key issue is not necessarily which technology or how much of it is used, but rather, how and to what purpose [Lai 2011; Serdyukov 2017; Viberg et al. 2019].

2 BUILDING ON EVIDENCE AND EXPERIENCE

The Universidad Tecnologica of Uruguay (UTEC) is a public institution operating in national campuses across the country. Since 2014, UTEC offers courses and programs catering to the needs of local communities. Since its inception, UTEC has sought to increase the use of technology and online learning. As learning designers and technicians, we set out to contribute to the integration process, by providing solutions, advice and technical support to the universities regional centres and individual teachers. Our efforts are not always as fruitful as we would hope, reflecting the problems mentioned in the introduction section of this article. Unsurprisingly, we see how institutional decision-making around technology adoption and use is a growing field of critical research in higher education [Holmes and Kozlowski 2015]. Although there is widespread agreement about the crucial role of professional development programs, the way forward is not always clear [Baran 2016; Holmes and Kozlowski 2015; Lock et al. 2019; Viberg et al. 2019]. There is extensive evidence on the effectiveness of tech integration in K12 teacher-training programs [Lock et al. 2019]. Conversely, the specific needs of faculty and university staff, and the effectiveness of tech integration initiatives in higher education have received far less attention [Holmes and Kozlowski 2015; Lillejord et al. 2018; Lock et al. 2019]. Experts propose programs that emphasise complex factors such as teachers' perceptions, lack of time, design skills, and institutional support [Baran 2016; Holmes and Kozlowski 2015; Lock et al. 2019; Viberg et al. 2019; Wei et al. 2009]. The importance of motivation as a driving force for classroom innovation is also highlighted in the context of higher education [Blaskova et al. 2014].

Our internal assessments reveal a distance between our university's teachers' perceptions and understanding about learning technologies, and their teaching practices[1]. This distance between 'knowing' and 'doing' is supported by large-scale research evidence [Ebert-May et al. 2011]. The distance between theory and practice is a key component of most K12 teacher training and professional development programs, and it is addressed directly through field experience (practicum) [Ebert-May et al. 2011; Wei et al. 2009]. This is not the case for faculty. Indeed, many faculty and university professors' field experience is limited to isolated technology workshops and pedagogy seminars, with little or no access to active, hands-on experience of pedagogy-based technology-use [Lock et al. 2019]. To some extent, this omission may be explained by universities and individual academics' self-perception as producers of academic knowledge. Academic knowledge can be described as a reflexive practice in the sense that it moves between contextualised and decontextualised knowledge, towards abstraction and generalization. For some, there is an epistemological difference between academic and other forms of knowledge [Lyotard 1984]. As Laurillard argues, university teaching is 'essentially a rhetorical activity' [Laurillard 2001] page 28.

We would argue that, while there are undoubtedly many instances of rhetoric in academic lectures, the failure to catch academics' attention when it comes to technology is not necessarily because they do not want it. Based on the evidence and the context of UTEC, we suggest that university teachers are best supported if they can explore technology 'by doing', but in a technology-based environment that is relevant to their field of knowledge and research. This is because university teachers are teacher-academics and, as such, it is within their field of knowledge that their motivation resides. By this we mean, that the technology has to be purposely used to explore discipline-specific knowledge and research. We argue that our task as 'tech' and design support is to collaborate with academics to identify such potential 'motivational' technology-based learning environments, and provide the resources and technical 'know-how' for them to explore and decide how this environment should be used. Such learning spaces could be developed in the context of faculty professional development programs, involving faculty, students, pedagogic developers, technical developers, and other key institutional stake-holders [Baran 2016; Holmes and Kozlowski 2015; Lock et al. 2019; Viberg et al. 2019].

With this in mind, the virtual reality learning environment (VRLE) as a virtual science labs is the natural technology to explore with bioscientists. We therefore propose to use the virtual lab as a 'learning space' for professors and teaching staff of lab-related disciplines, combining discipline-specific knowledge and skills with hands-on experience of using technology to support student learning.

3 SETTING UP A VRLE IN UTEC

In 2018, UTEC developed its first 3D environment to support student learning. The main objective was to produce a 3D space, which all lab-discipline students across the three regional campuses of the University would be able to access. Providing the teaching staff with an educational technology would also allow them to explore the technology for blended learning and flipped classroom approaches in lab-related teaching. The very first version was developed using a 360 camera to record the lab areas, accompanied with a mobile app for android. However, the original version of the virtual lab was limited in its functionality due to the poor usability of its interface, making the operation and interaction difficult, not only for teachers to set up, but also for students to access.

[1] During 2019, we analysed faculty online surveys, workshop questionnaires and LMS data.

The original version was updated in 2019, when the University acquired a new 3D camera with integrated web software. In March of this year, our staff visited five different campuses with lab-disciplines in order to map and record the physical spaces. The rendered environments were uploaded to the online site used for digital educational resources and environments: red.utec.edu.uy. A small number of teachers were asked to collaborate using the tagging system in order to edit the virtual spaces according to the specificities of each discipline or program, making sure that the information was useful and relevant to their needs. Those teachers received login details and support to ensure they would be able to carry out the task. In the current system, students are not able to edit the virtual spaces. However, the tags system makes it possible for students to explore 3D spaces, search for information and identify important areas and lab equipment. The information in the tag system includes text and external links (images, videos, books, etc.), which teachers can link to any area, equipment and instrument found in the virtual space. By the end of May this year, all 3D spaces had been rendered and teachers had begun to edit and upload information online. Considering the complexities of setting up a new VRLE for a multi-campus university, we are confident that the set-up process was a collaborative success. As we mentioned in the introduction, the issue now is putting the environment to work.

4 PUTTING THE V-LAB TO WORK

There is a fair amount of evidence of the benefits of using VRLE for learning [Wang et al. 2015]. More specifically, VRLE have been found to improve student examination outcomes [Lewis 2014]. However, this is on the premise that the VRLE is fully developed and the VR sessions are expertly planned and executed [Lewis 2014]. At the moment, our V-labs do not include sophisticated interaction and simulations like the kind we see in commercial VRLEs available on the market[2]. However, the technology is user-friendly and can be used for complex learning activities, which can be stand-alone, or as part of experiments performed in the real, physical labs. However, time passed and none of the teachers were putting the labs to work. The first step at this point was to discuss with the biosciences teacher/academics that had been involved in the recording and set-up process of the labs to see if they had used any part of the technology, and if they had reflected upon any potential uses. It emerged that the labs were mainly seen as a good outreach tool, used to motivate secondary school students and other prospective students to apply to the university. They were now able to show external audiences a virtual tour of the university, and especially, of the science labs. The labs were not being used to support learning.

After getting this information, we went back to the technology to explore the functionalities which we thought could have educational potential, and later had more conversations with teachers. This time we had a lot of questions about what happens in a science lab on their watch: 'Where do you start?', 'How do your students learn about the equipment?', 'What do you want them to find out?', and 'How does that information reach them?' were some of the questions we asked. By the end of the day, we could see that the teachers did see potential uses for the technology, but perhaps were not sure of how to exploit the specific functionalities, or what could actually be done with them. Through our conversations we all ended up with a better understanding of how the technology might support lessons, pre, during and after visits to the lab. We were able to come to some productive understanding of how the Virtual Labs in their current form could support learning in the biosciences in UTEC. Some examples of the things we discussed with faculty were:

Laboratory Protocols

When a new students start any course which includes lab-work, they will dedicate some time and their first visit to the lab, learning about safety, lab practices and protocols. They have to learn how to protect themselves and others from potential hazards and learn how to use the equipment and accessories appropriately and safely. While teachers can go through this kind of information in class and it can be handed out to students during their first visit to the lab, there is a lot of new information to remember and little time to go through all the spaces, equipment, procedures and accessories. In the virtual lab, teachers can use link images and videos to bring protocol lessons to life. For instance, equipment video-tutorials, microscopic imaging, or videos with experiment procedures can be tagged to specific equipment or areas in the virtual space; all of which can be explored from anywhere, at any time, and as many times as necessary.

Experiment Results

Another possible use that teachers found valuable is to be able to upload experiment results to the virtual lab. This is because some experiments take time to show results and, as a result, the analysis process can be experienced by some students as unconnected to the process. Unlike the scientists that spend all day in and out of labs, some students will only be in the lab for a short period of time,

[2]See, for instance, the award-winning company labster.com

and not be allowed back in until the next experiment or procedure takes place. Teachers will usually simply share experiment results with students through the LMS, which students can then analyse. Having the virtual lab means that teachers can upload recordings or data of the results to the specific equipment, allowing the student to experience the actual work of the scientist; having to go back to the virtual lab the next day, to check what happened to the organisms, compounds, substances, etc.

Keeping Science Fun in the V-lab

The most interesting conversation we shared with teachers was about how the virtual lab could keep science fun. Academics have a holistic understanding of their science, which connects lab-work to the results, the graphs, the calculations and analysis and further testing. Students get a fragmented picture of this world, mainly due to the costs associated with labs, and wet-labs particularly. Teachers find themselves turning applied knowledge and 'doing' into theorised learning *about* the 'doing'. Teachers described this as turning something fun into something boring. For example, one academic explained that they teach all techniques, such as DNA sequencing for example, without ever going into the lab. And despite their best attempts to make it interesting, lessons are often built around highly decontextualised and abstract knowledge. Virtual labs could be used to teach, for instance, DNA sequencing, allowing students to get a holistic, contextualised understanding of how all the steps fit together, how they connect with theory, and the results they produce. Indeed, the tag system could be used by teachers to create a learning path that displays information inside the virtual lab. Once a student has chosen a sample, and has identified the machine they have to use to start the process, the teacher can have a tag ready with a link to a 3D animation that shows the student what happens to the sample inside the machine, at a molecular level. Just like the scientist, the student is able to get a visual, hand-on, holistic view of a specific testing procedure.

5 UNDERSTANDING TECHNOLOGY-DRIVEN INNOVATION

There are some important points to be made about this technology in particular, and its integration in higher education. As we mentioned in the beginning of the article, the integration of technology in higher education is a complex, multileveled process. What the technology of the V-lab explored in this paper helps to illustrate, is the importance of taking into account the specificities of higher education as well as what academic content is taught, and how it is taught by academic teachers: First, is the lack of opportunities available to academics to practice and explore active teaching strategies (with and without technology). Higher education institutions tend to rely on individual teachers' classroom innovation, and make general demands of a kind of teaching praxis that teachers must first learn in practice. Hence, before teachers can apply technology-based teaching, they have to practice technology-based learning. Or put in other words: Academics that teach need to have their 'teaching practice labs' to learn 'by doing'.

Second, when we introduce technology, we must consider how any use of technology can be made relevant to the specific discipline. Indeed, it is no use giving seminars about the importance of learning objectives if we do not also create spaces to connect theory with practice, and while theory can remain general, practice is always content-specific. Indeed, the same technology can be used in completely different ways and for different purposes depending on the discipline and its practices. Once the virtual lab had been set up and running, the difficult task of working with academics began, where the virtual lab must be turned into a space of learning, not for students, but for teachers and researchers. The learning is active, through discussions about bioscience didactics, the virtual lab technology, and the intended student experience.

Taking higher education teachers' motivation seriously, means opening up spaces for collaboration between our tech-oriented view and their discipline-specific expertise. Our task is to come up with concise and practical ideas for the virtual lab so that teachers can see the relevance to their academic knowledge. The purpose of our collaborative work is to engage academics with pedagogically-driven technology use, in the hope of awakening their curiosity and motivation to explore other functionalities and develop their ideas further into actual 'learning experiences'. The collaborative process is the trigger to such learning practices in UTEC, which means we must now take the lessons learned and create more collaborative, technology-based learning spaces available for our academics to practice teaching.

REFERENCES

Key Balasubramanian, W. Clark-Okah, J. Daniel, F. Fereira, A. Kanwar, A. Kwan, J. Lesperance, J. Mallet, A. Umarand, and P. West. 2009. ICTs for higher education: Background paper from the Commonwealth of Learning. *Paris: UNESCO* (2009).

Evrim Baran. 2016. Investigating faculty technology mentoring as a university-wide professional development model. *Journal of computing in higher education, 28(1)* (2016), 45–71.

Martina Blaskova, Blasko R., and Kucharcikova A. 2014. Competences and competence model of university teachers. *Procedia-Social and Behavioral Sciences, 159* (2014), 457–467.

Manuel Castells. 2000. *The Rise of the Network Society.* Oxford: Blackwell.

Diane Ebert-May, Derting T. L., Hodder J., Momsen J. L., Long T. M., and Jardeleza S. E. 2011. What we say is not what we do: Effective evaluation of faculty professional development programs. *BioScience, 61(7)* (2011), 550–558.

Courtney M. Holmes and Kozlowski. 2015. Tech support: Implementing professional development to assist higher education faculty to teach with technology. *Journal of Continuing Education and Professional Development, 2(1)* (2015), 9–20.

Kwok-Wing Lai. 2011. Digital technology and the culture of teaching and learning in higher education. *Australasian Journal of Educational Technology, 27(8).* (2011).

Diane Laurillard. 2001. Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies. *New York/London: Routledge* (2001).

David Lewis. 2014. The pedagogical benefits and pitfalls of virtual tools for teaching and learning laboratory practices in the biological sciences. *The Higher Education Academy: STEM* (2014).

Solvi Lillejord, Borte K., Nesje K., and Ruud E. 2018. Learning and teaching with technology in higher education a systematic review. www.kunnskapssenter.no. *Oslo: Knowledge Centre for Education,* (2018).

Jennifer Lock, Johnson C., Altowairiki N., Burns A., Hill L., and Ostrowski C. P. 2019. *Handbook of Research on Blended Learning Pedagogies and Professional Development in Higher Education.* Chapter Enhancing Instructor Capacity Through the Redesign of Online Practicum Course Environments Using Universal Design for Learning, 1–20.

Jean-Francois Lyotard. 1984. The PostModern Condition: A Report on Knowledge. *Manchester: Manchester University Press* (1984).

Peter Serdyukov. 2017. Innovation in education: what works, what doesnt, and what to do about it?,10(1). *Journal of Research in Innovative Teaching and Learning* (2017), 4–33.

Olga Viberg, Bälter O., Hedin B.and Riese E., and Mavroudi A. 2019. Faculty pedagogical developers as enablers of technology enhanced learning. *British Journal of Educational Technology, 50(5)* (2019), 2637–2650.

Jingying Wang, Guo D., and M. Jou. 2015. A study on the effects of model-based inquiry pedagogy on students inquiry skills in a virtual physics lab. . *Computers in Human Behavior vol. 49,* (2015), 658–669.

Ruth C. Wei, Darling-Hammond L., Andree A., Richardson N., and Orphanos S. 2009. Professional Learning in the Learning Profession: A Status Report on Teacher Development in the US and Abroad. *Technical Report. National Staff Development Council.* (2009).