Lockdown: Experiments with virtual science laboratories in Further Education.

University of Sunderland

EDUCATION & TRAINING FOUNDATION

Introduction

This study is concerned with students at a large midlands Further Education (FE) college and how they respond to the use of virtual laboratories. Following science courses, our students are familiar with the "normal" school or college science laboratory. Virtual laboratories have existed for a number of years and recently have increased in sophistication. These computer based simulations can be quite simple or a highly detailed representations of a real laboratory. Some of the newest versions are based in virtual reality, providing an even closer feel of the real laboratory.

Virtual laboratories are widely used in Higher Education (HE) (Lewis, 2014). They offer a good way for students to develop practical skills. Miller, Carver and Roy (2018) found no difference in outcomes compared to real laboratories. So, it would seem reasonable to use them in an FE setting, however, there is little evidence that this is presently the case.

FE does present some particular challenges compared to HE, including funding, limited facilities, student motivation and prior attainment (DoE, 2018). However, the recent COVID-19 related closure of the College, means that virtual laboratories are now the only ones available to our students.

Methodology

The questions

- Does teaching practical science in a virtual laboratory increase students' skills and understanding in the same way? (Sennett, 2009)
- How do our students feel about their learning?
- Will our students develop the employability skills required by employers?

The Students

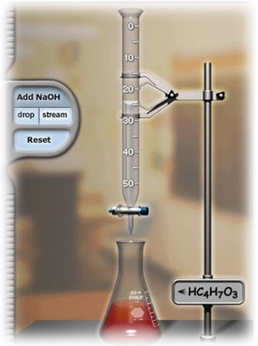
The students are studying at level 2 and level 3, following BTEC Applied Science programmes. These students come with a wide range of experience; the majority coming from ethnic minority backgrounds, many are non-native English speakers. Often, they have previously been disappointed by low levels of attainment. Many lack self-confidence and resilience when faced with new challenges.

The Questionnaire

The method chosen for this study is a questionnaire. The questions are designed to reflect the five outcomes for practical science (see Box to right) identified by Holman (2017). There are two questions about each outcome, the first, on a five-point Likert Scale and the second, a more open question, inviting a text answer. Both questions address the comparison of experiments carried out in real laboratories with those in virtual laboratories.

The questionnaire was presented as an additional task after the completion of a virtual laboratory similar to a real practical exercise which had been undertaken earlier in the year. This is not an ideal way to make the comparison, which may bias the results. However, under the circumstances of College closure it is the best option available.

If we look at the results from a qualitative view-point, then we can hope to gain some useful insights. Following the work of van Maanen (see Connelly and Clandinin, 1990) we can concentrate on the verisimilitude of the comments rather than their strict validity.



Virtual Laboratory

Practical Science

Why we do it:

1. **to teach the principles of scientific inquiry**
2. **to improve understanding of theory through practical experience**
3. **to teach specific practical skills, such as measurement and observation, that may be useful in future study or employment**
4. **to motivate and engage students**
5. **to develop higher level skills and attributes such as communication, teamwork and perseverance**

Holman (2017)

Real Laboratory

It's good that you can go through it more then once and not have to spend time clearing experiments up

If you do something wrong in a physical experiment you may have to start the whole experiment again but with virtual you can just start that part again

Like the videos and the animation in virtual lab

Yes, as I can re- read pieces of information and gain a new understanding. I can also take my time to help me understand the theory etc.

online labs can be exciting because I can sit in my own time and take the time to practice and read the work and complete it

In a way because it is more visual and personal

Yes because its a professional doing the experiment so all the little details will be made clear

Learn more from physical as you can ask question and actually do it physically

Your doing the experiment physically so you can remember what your doing

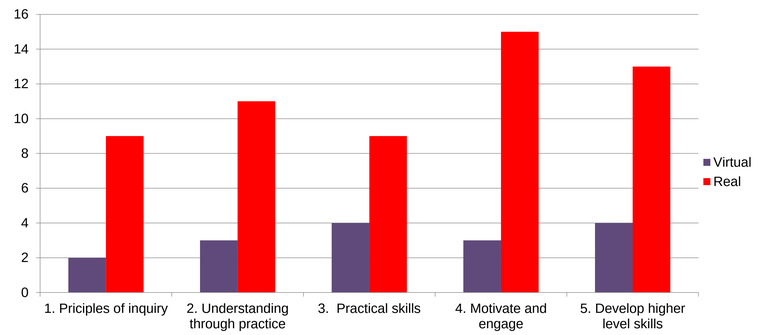
Physical, it's good practice for future

No, still think that physical laboratories are better

Gain more understanding using real practical experience

is useful but, but is not the same thing because sometimes we need the teacher helps and explanation

Analysis



- The Likert data is shown in the figure above, where only the combined preferences for each type of laboratory are shown (a total of 21 responses; neutral omitted). The data shows a preference for learning in real laboratories.
- Students' textual responses (shown right, in purple [virtual] and red [real] boxes) are more favourable to the use of virtual laboratories than suggested by the Likert scores.

It may be useful to speculate why this is the case:

- The virtual laboratory is technology dependent, the students were using a range of devices, giving a range of experiences and unfamiliar software can lead to frustration.
- The effect of lockdown may influence a students' desire to be in a physical laboratory, as may their physical environment while completing the task.
- Data and comments suggest that motivation is a big issue.
- Students language abilities may reduce the quality of their interaction with virtual laboratories and their willingness to make a written response.

Ideas like "exciting", "visual and personal", "gain a new understanding" suggest the value of the new technology. While, the need to "actually do it physically" and gain "understanding using real practical experience", suggest something may be lost in the virtual world.

Conclusions

This limited study has suggested that there are a number of factors which could influence the successful implementation of virtual laboratories in FE. Students can be excited and motivated by new technology, but difficult to use technology or software cause issues. Unlike many university students, FE students may lack the physical, academic and emotional resources or resilience needed to make the most of the new opportunities. Language abilities may inhibit access to new ways of doing things. Some students value the physical laboratory "because sometimes we need the teacher": this need should be considered when implementing virtual applications for FE students.

There needs to greater understanding of both the intellectual and emotional experiences of learning through virtual laboratories, in order to make the most of these resources.

Recommendations

- Care needs to be taken during the planned implementation of virtual laboratories in the College; this will enhance the students learning experiences.
- The technology, software, language and assessment need to be chosen to align with the desired intellectual and emotional outcomes (Biggs, 2015).
- Outcomes should reflect the value that practical science can give in educating FE students.
- Implementation needs to be monitored and studied to allow careful reflection.
- Gaining an enhanced understanding of the process will allow an informed crafting of the curriculum and achieve the best use of virtual laboratories.

Key Literature

Biggs, J.,(2015) 'Aligning teaching for constructing learning' https://www.heacademy.ac.uk/sites/default/files/resources/id477_aligning_teaching_for_constructing_learning.pdf

Connelly, M.F., and Clandinin, J.,(1990) 'Stories of Experience and Narrative Inquiry', *American Education Research Association Journal,* Vol.19., Issue 5, pp. 2-14. June 1990. DOI https://doi.org/10.3102/0013189X019005002

Department of Education (DoE) 2018, 'Destinations of key stage 4 and key stage 5 students, England, 2016/17'

Holman ,J.2017) *Good Practical Science*, Gatsby Foundation, https://www.gatsby.org.uk/uploads/education/reports/pdf/good-practical-science-report.pdf

Lewis, D. (2014) *The pedagogical benefits and pitfalls of virtual tools for teaching and learning laboratory practices in the Biological Sciences*, The HE Academy, https://www.heacademy.ac.uk/sites/default/files/resources/the_pedagogical_benefits_and_pitfalls_of_virtual_tools_for_teaching_and_learning_laboratory_practices_in_the_biological_sciences.pdf

Miller Travis A., Carver Jeffrey S. and Roy Abhik (2018) 'To Go Virtual or Not to Go Virtual, That is the Question : A Comparative Study of Face-To-Face Versus Virtual Laboratories in a Physical Science Course', *Journal of College Science Teaching*, 48(2), p. 59. Available at: http://search.ebscohost.com/login.aspx?direct=true&db=edsjsr&AN=edsjsr.26616271&site=eds-live&scope=site (Accessed: 7 February 2020) & references there in.

Sennett, R. ,The Craftsman, 2009, London, Penguin Books, p.41.

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