An investigation into the use of virtual reality on assessment

A pilot study carried out at The Sheffield College through the Assessment Innovation Fund in collaboration with NCFE.

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The Sheffield College, which is Ofsted graded 'good', is a further and higher education college that educates and trains around 14,000 young people and adults a year. Its mission is transforming lives through learning. The college's vision is to become a leader in technical and academic education, creating exceptional opportunities for the communities that it serves to realise their aspirations.

The college offers a wide range of academic, vocational and professional qualifications including apprenticeships, vocational diplomas, A Levels, access courses, and foundation and honours degrees. Students learn in industry-standard facilities.

The college is committed to the continuous professional development (CPD) of its staff and the latest teaching, learning and assessment skills. This has been demonstrated by investment in CPD training facilities with two staff innovation centres based at its City campus and Hillsborough campus.

As an institution, The Sheffield College, and Steven Spence the project leader, place a high emphasis on evidence when implementing new methods. This is certainly shared with NCFE, and something that aligns our aspirations to innovate practices, in this case assessment through verified research. As a college, we want to understand more of what works and why, and also how best something works and in what circumstances. All education technology implemented at The Sheffield College is done following careful consideration, research and pilots, and a wealth of primary research is considered to underpin the innovation.

Abstract

This pilot was supported through the Assessment Innovation Fund (AIF) through NCFE. The aim of the pilot was to investigate the use of virtual reality (VR) on assessment. To achieve this aim three curriculum areas were used for the pilot, these were animal care, catering and carpentry and joinery. In total, 41 students took part in the pilot, with five staff, comprising of curriculum staff and the Digital and E-Learning Team at the college.

VR experiences and assessments were designed and created to collect data, with data collated during the actual VR assessment used to ascertain the impact of using VR for assessment. In two of the curriculum areas a delayed assessment was also completed after 24 hours of the initial VR assessment, to analyse the role VR could play in enhancing the retention of knowledge and information.

The perceptions of both staff and students were also collected through surveys, focus groups and participant observation. These methods were important and employed to achieve a key objective of the research, which was to ascertain the views of staff and students. These methods were the most appropriate for this research, but it is acknowledged that a limitation of these methods in the framework of this research was that they collected the views and opinions of staff and students at one moment in time, as opposed to longitudinally. However, this will be completed in subsequent research following this pilot.

Results indicate that students performed very well in the VR assessments, and the retention of information was high as evidenced through the results of the delayed assessment. Data from the questionnaire and focus groups also indicated many positive aspects, especially concerned with engagement, accessibility & the ability to practice and hone skills and knowledge. The only concern from the feedback was the comfort of using the VR headsets. Staff feedback was also positive, but it is vital for the successful implementation of VR in mainstream education that staff feel confident in using VR.

On completion of the pilot study the following recommendations are offered:

- Successful implementation has to be led from a curriculum teacher/team who have reflected on their curriculum content.

- The support from digital specialists is of paramount importance.

- Inductions and training for both staff and students is vital for success.
- From a technical perspective, any institution should make sure they have the desired set up, including networks, software and hardware to implement VR effectively.

- Finally, an institution should utilise students when researching the best VR kit in terms of comfort and adaptability.

Research should continue to focus on the use of VR on assessment but other uses of VR could be explored in addition to this. Good examples of this are the utilisation of VR to create campus tours for new students, or the orientation of certain resources in a college, for example a practical laboratory. These steps extend VR beyond assessment and offer excellent opportunities to enhance processes and procedures

Key Words

Virtual reality, assessment, learning

Introduction

Pilot Overview

The aim of this project is to investigate how virtual reality (VR) can be used effectively in summative and formative assessment. The pilot will be carried out in three different curriculum areas so findings can be compared and contrasted, giving greater insights and scope for evaluation. The role of assessment in education has been heavily researched (for example, Black and Wiliam, 1998; Black et al, 2003; Klenowski, 2009; Shute, 2007), with an increasing number of articles focusing on how technology can support assessment (Alruwais, Wills, & Wald, 2018). Moreover, and pertinent to this project, is the use of high fidelity situations through VR, and how these methods can support and enhance approaches to assessment. Research has shown positive impacts of VR in educational settings (Zhao et al, 2020) and through this pilot VR will be investigated for both formative and summative assessment processes. Furthermore, this project will be specifically aligned to the requirements of awarding bodies, ensuring that findings are relatable and impactful for the sector, both in terms of institutional approaches to assessment (i.e. college, school, independent provider) and to awarding body approaches to assessment.

Pilot Aim

Investigate the impact VR can have as a transformational approach to assessment to support students to develop advanced knowledge, skills and behaviours. This was underpinned by the following objectives:

- Analyse the impact of VR on the performance of students in assessments.
- Evaluate the impact VR can have to support the long-term learning of knowledge, skills and behaviours when tested through a delayed assessment.
- Discuss the views of both staff and students on their experiences of VR and how it could enhance assessment in the future.

In addition to the formal objectives listed above, the pilot will highlight any recommendations of note in terms of the implementation of VR that may support other institutions on a similar journey. Although not a formal objective, any learnings from this pilot will be shared to support other institutions.

Rationale

As a college we have made much progress in recent years in all aspects of our TLA, use of education technology (EdTech) and innovations in both our curriculum design and delivery. Furthermore, our sector-leading digital development programme ensured that throughout the pandemic we could offer high quality learning through online and blended methods. We are now in a position to continue pushing the boundaries, utilising technology to innovate for the benefit of our students.

Following our own internal reflections as a college, including discussions with curriculum leaders, one aspect we are keen to enhance is our assessment in environments that require professional practice. Recently our catering, animal care, and construction teams have all shown interest and discussed how VR could support with the delivery of their programmes by offering greater opportunities for students to learn, and apply learning in a professional environment. Furthermore, engendering this through innovative curriculum planning and delivery would support students to develop the skills that are so important to professional environments, thus taking learning beyond the learning of facts and content.

As we reflected on our continued improvement we started to consider how best we could support curriculum areas to accomplish the above, which led us to considering how VR resources could be developed and implemented. VR is not new in education but certainly not prevalent, and it gives an opportunity to create real-world learning that would solve the aforementioned problems of students learning in professional settings. Moreover, a catering student may only get two sessions in the practical setting of a kitchen per week, due to course demands, timetabling, the amount of other courses and students etc. All of these are commonplace in educational institutions but it leads to students not being able to practice in these settings as often as possible. Add to that the cost of creating a fish dish, or a main course with ingredients that can only be used once, and it is clear that there is a limit on the amount students can practice in these environments, which means there is a limit on the assessment and feedback they can gather.

VR could potentially address these issues, supporting students to access and re-access learning materials as much as they wish until they master a given skill or behaviour, supporting them to become autonomous, self-regulating learners who reflect on their strengths and areas for development continuously to improve.

Virtual Reality

In simple terms, VR replicates the real world and offers students first-person experience in such environments through different levels of immersion (Zhao, et al., 2020). VR can give students access to opportunities with high fidelity - the degree to which the simulated environment corresponds to the real world, which they would not have access to without VR. Careful planning is required to ensure that the implementation of VR supports and extends learning, for example, the degree of fidelity may differ from novice to experienced students, with the latter requiring VR environments that closely resemble real work environments (Gulikers, et al., 2005). VR used in subjects such as anatomy and physiology would immediately spring to mind and evidence suggests a positive impact for these programmes (Zhao et al, 2020), but colleges and educational institutions should consider many of the opportunities to enhance provision through the use of VR, and that was pertinent for this pilot.

What we planned to do in this pilot was develop a range of VR resources for a variety of curriculum areas, namely catering, animal care and construction. On completion of the pilot it was hoped that more curriculum areas will implement VR to enhance their curriculum. These resources were used for both formative assessment, i.e. support students in the

learning process, and summative assessment, against specific awarding body criteria. To support with the former, the lead teachers in the pilot worked closely with the Digital and E-Learning Team to create excellent formative assessment through the VR resources. Furthermore, the development of professional practice and self-regulation (agency) were woven into the resources. To support with the latter (summative) the head of cross-college quality and compliance was utilised as part of the pilot to ensure that the VR resources designed met awarding body requirements and the specific unit criteria.

Methodology

The methodology for this pilot utilised aspects of the mixed methods approach. This enabled quantitative and qualitative data to give valid and accurate results through triangulation. For example, quantitative data will be assessed through a range of tests completed in VR, both standardised academic progress tests and devised student self-assessment tests. This data will be supplemented through a range of student and staff interviews and focus groups.

The methods to enable data to be collected will be as follows:

- Academic progress tests
- Student self-assessment tests
- Interviews and focus groups

All aspects of the sampling for the pilot is based on purposive sampling, i.e. those who are chosen meet the needs of the research aims and objectives. In this case, three academies will be selected as part of the initial pilot, which will enable the pilot to be thorough, with the research carried out in line with academic research principles and NCFE principles.

Purposive sampling was required in this situation to ensure that the academies used in the pilot were appropriate, as opposed to random sampling which may have selected academies who are presently not appropriate. Moreover, as these pilots are to be carried out with internal college academies, the needs and progress of these academies is well established and understood by the project lead in terms of innovation, assessment, current use of education technology and priorities for the upcoming academic year. This further supported the use of purposive sampling.

Purposive sampling was once again used to select the student groups with which to trial the initiative. This was agreed with the respective academy heads and lead teachers within the pilot to ensure that the student groups selected gave valid and accurate results, with reliability also considered through the replication of the pilot to a wider audience in subsequent years. As previous, purposive sampling of student groups ensured that the pilot study was carried out with groups and teachers who are actively looking to enhance their approaches to assessment, thus meeting the aims and requirements of NCFE and the pilot. For example, the catering team had identified the need to give greater opportunities for students to practise in real-world settings, which they only have limited access to in the college kitchens. This was also the case for animal care who can only offer limited

experiences in work-related settings. Finally in construction, students are not permitted to train and access certain settings, due to safety and legislation. All three academies had expressed an interest in using VR following previous internal training days, and these selected academies enabled valuable pilots to be completed.

The variety in the academies used in the pilot offered heterogeneity to the extent that each academy was different in terms of course structure, qualification, and awarding body requirement. Furthermore, the group levels were also varied, with catering focused primarily on level one students, construction level two, and animal care level three.

The size of the sample, which included four lead teachers and 41 students, enabled a large enough sample to make accurate generalisations and future recommendations, but also enabled a relatively small research team to conduct the pilot in the most effective way, for example, when analysing the data.

The inception of the pilot followed the below format:

Stage	Description
Stage 1	Meeting with selected academies and lead teachers to explain the process of the pilot, including aims and objectives and ethical considerations.
Stage 2	Creation of VR materials and resources. Within this stage, the college's digital and e-learning team played a key role in working in collaboration with the respective academies and lead teachers to create the VR resources.
Stage 3	Implementation of pilots in each academy.
Stage 4	Data collection and analysis, including interviews and focus groups.
Stage 5	Pilot review and evaluation, including synthesis of next steps and dissemination cross-college.
Stage 6	Dissemination to the wider sector.

Data Analysis

Descriptive data was used to support the analysis of the internally devised progress and self-assessment tests. The internally devised progress tests measured students' knowledge of content through VR, with the self-assessment tests used to measure students' perceptions of VR.

Data obtained in the focus groups was analysed through thematic analysis (Braun & Clarke, 2006) to ensure a greater insight through qualitative methods was achieved, enhancing the quantitative data obtained. Braun and Clarke's (2006) six-step approach to thematic analysis (TA) enabled the development of clear themes from the data and match the underlying methodology and approach of the research. The six steps are detailed below:

1) becoming familiar with the data,

2) generating codes,

3) generating themes,

4) reviewing themes,

5) defining and naming themes, and

6) locating exemplars.

One of the main strengths of using Braun and Clarke's (2006) model is flexibility in terms of research design and epistemological and ontological standpoints. This is because TA is simply a method of analysing the results, not a complete research methodology in itself such as Interpretative Phenomenological Analysis (IPA) or Grounded Theory (Braun & Clarke, 2013). TA is also more appropriate for creating themes across a larger sample size as opposed to IPA, which has the 'dual focus on individual cases and themes across cases' (Braun & Clarke, 2013, p. 183).

These methods of analysis ensured rigour, and that the findings were valid. This was crucial for the pilot in adding to the college's internal evidence base for the future of VR in the curriculum, and when disseminating findings to the wider educational community. The range of methods, both qualitative and quantitative, and the approaches to data analysis ensured triangulation of findings, and that assumptions made from the pilot were authentic and trustworthy.

This pilot study did not create major concern from an ethical standpoint. There was no risk of harm for any participants, staff or students. No personal data was shared in any form, and the results were fully compliant with educational standards, including safeguarding and GDPR. Furthermore, the pilot was based on a new pedagogical approach used to enhance assessment and delivery, which is no different to a teacher trialling a new questioning technique in their practice, or a new approach to group work. All college data was used in correspondence with internal codes of practice, and the focus groups were carried out in line with internal student voice procedures. Furthermore, as stated above, thematic findings from the focus group were based on holistic opinions with full anonymity for all participants. Finally, students were instructed prior to taking part in the VR data collection that if they did not feel comfortable during their VR experiences, they could access the footage and experiences through normal video software.

Strategies to ensure trustworthiness were important for the credibility of qualitative research

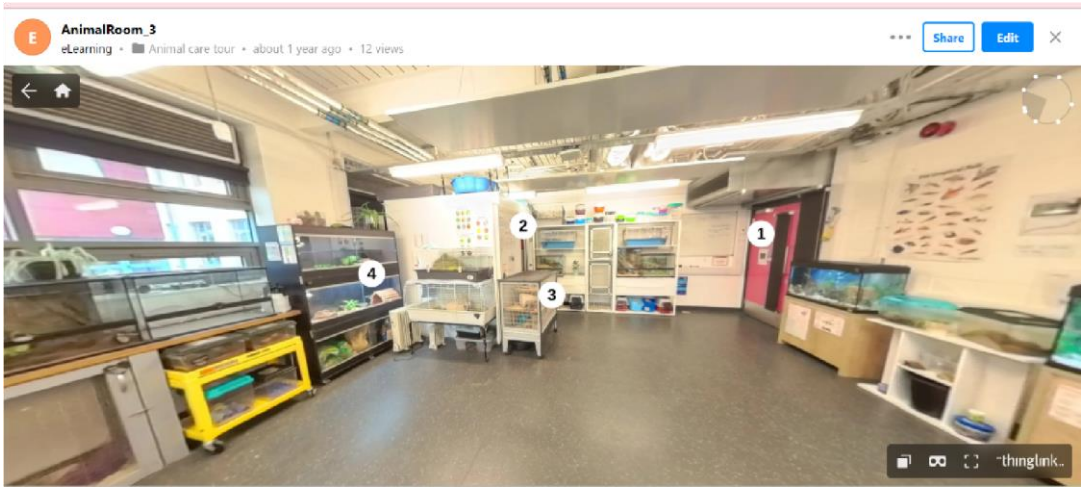
(Shenton, 2004) and a concerted attempt was made to ensure the four criteria defined by Guba (1981) were adhered to. This included the production of a detailed methodology to ensure that the study can be replicated in the future; defining the context for the research to enable readers to have clarity on the environment; ensuring the research was a true reflection of the phenomenon under investigation and that the findings are constructed from the data and not the researchers' own predispositions (Shenton, 2004). These principles helped the pilot team ensure trustworthiness throughout the process.

Procedure

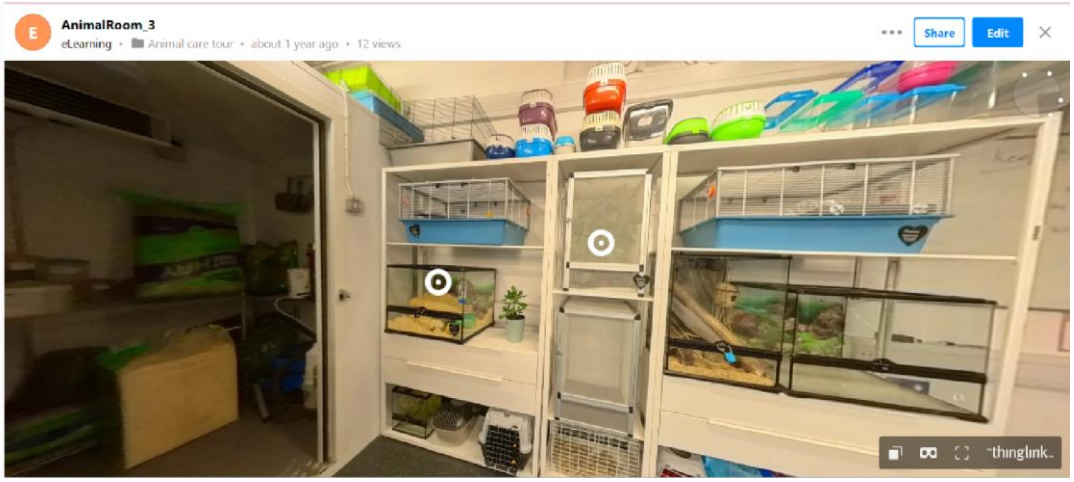
As stated, three curriculum teams were involved in the project, these were catering, animal care, and carpentry and joinery. None of the students or staff had used virtual reality within lessons before this project.

The principle of the Virtual Reality (VR) resource was two fold; firstly the students would use a teaching version of the VR resource and 'visit' the area to learn about aspects of the curriculum pertinent to the course.

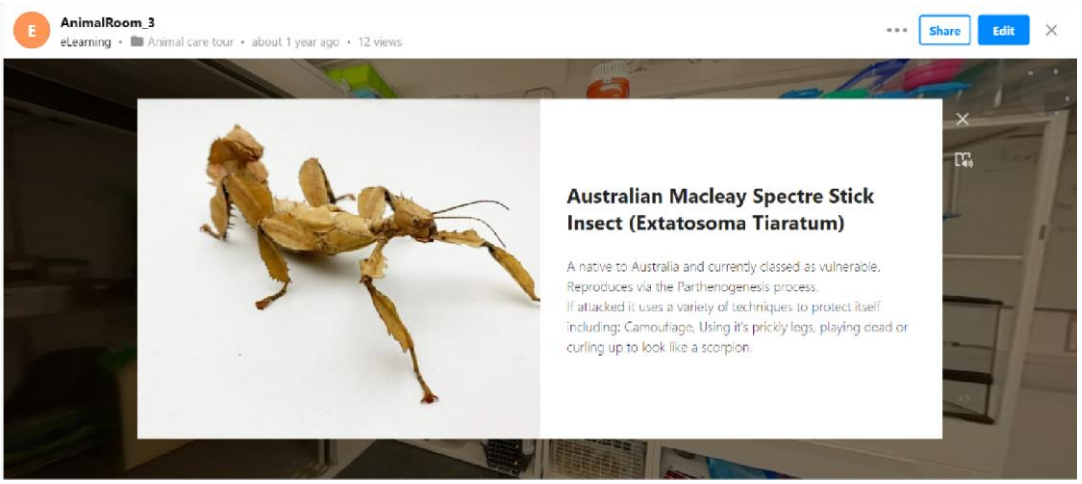
This 'teaching' version had hotspots on areas of interest. If the student clicked on the hotspot then a window would appear and give the student a breakdown of information regarding the specific content. The information on each of the hotspots was linked to the assessment questions, with the contextualisation of learning hypothesised to support students' long-term learning.



The above image shows the start point within the animal care VR resource.



The above image shows the hotspots.



By clicking on a hotspot the student would then see and be able to hear this information. To support the diverse levels of learners, each learning point within the VR resource had an immersive reader which would allow the learners to hear the text spoken to them.

Prior to data collection students were given a thorough induction on the VR headsets, ensuring they could navigate content easily. The curriculum staff involved in the pilot had also been trained on the use of VR, and had become confident users. Members of the Digital and E-Learning Team at the college supported throughout the pilot, including the data collection sessions.

To collect data, students completed a series of questions built into the VR experience. The answers were then logged within the software and the students and staff can view the responses. This ‘assessment’ version of the VR resource didn’t have hotspots which the students could click on. It only showed them questions when they were happy to proceed.

Finally the students completed an electronic questionnaire through a Google Form which replicated the questions in the VR resource. The electronic questionnaire was shared with

the students 24 hours after they had completed the VR experience, enabling the gathering of evidence as to the retention of knowledge and understanding.

Results

Animal Care:

The animal care resource was created using a central point which the viewer could use as a starting point to then go and see other points in more detail. This was done as it is a single space with a large walk-in fridge in the corner. The individual animal enclosures needed a more detailed photograph to support the text given about each animal.

The room was remodelled after the 360 images were taken but none of the students commented on this in a negative way.

Animal care data:

- Average interaction time 14.92 minutes.
- A combination of level 3 first and second years and level 4 students completed the project, totalling 14 students.
- Average percentage score across the data during the VR assessment was 92%.
- Average percentage score across the data in the delayed assessment was 86%.
- Six students scored higher in the VR experience.
- Six students scored the same in both the VR experience and the delayed assessment.

- Two students scored higher in the delayed assessment.

Animal care assessment comparison:

User	VR resource score (%)	Google form questionnaire score (%)
748189	100	83
757449	89	89
766359	78	89
768664	72	72
768926	100	94
773001	100	94
773741	100	100
784131	94	83
784856	100	50
784927	78	89
786052	94	94

787208	89	78
789628	100	100
796852	94	94
Average percentage score	**92**	**86**

Data was also gathered on the perceptions and experiences of the students regarding VR. This data was collected through a short survey, with the results detailed below.

Animal care student feedback: Below are some of the extracts from the feedback questionnaire completed by the students.

What are your initial thoughts of virtual reality being used in education?	Are there any main positives that you gained from using VR?	With the tests continuing what could be gained in the future from the use of VR? (Think about in lessons, how may this help you with your learning?)	Are there any negatives to using VR for you?	Do you have any other thoughts or comments?	Have you got any ideas of what could be added to VR to help students?

Very cool, I think it has a lot of potential and could really alter the education system for the better. I think it gives students who struggle with the writing and focusing aspect of learning a chance to express their knowledge in a new way, one which suits them much better.	New experience, good bonding opportunity for students as well.	It could provide the opportunity to have multiple practical lessons, or lessons that require presence in the animal room.	Headaches from the headset, and people who struggle looking at screens for extended periods of time may find it difficult.	The guy with the tattoos and pony tail should join the animal care faculty because he's cool. In all seriousness, it was really useful to do an assessment in this way.	Tours of places like Heeley city farm or Mayfield could be beneficial to get a wider range of animals for students to observe.
It's sounds cool and intriguing.	It's accessible.	Could safely teach dangerous animals handling, before doing this for real.	Potentially not very compatible with people who wear glasses.	n/a	n/a

It was a little confusing at first and gonna cost a lot of money.	It was fun.	A different way of learning and being assessed.	It is a little confusing at first.	Nope.	More questions on animals and more experiences.

It’s a good idea but some students such as myself might not know how to use it so you will have to teach them how to use it.	You get to experience new things while using it instead of having to actually going and doing it.	If you're unable to work with an animal due to possibly being allergic to them you could use VR to interact with that animal so that you can still say that you have worked with them.	I didn’t know how to work the headset as it was my first time using it so it was a little confusing for me at first.	It was good to use because it showed you everything that you would see during a lesson but it also had a test in it which allowed you to see what you did and didn't know.	
I really enjoyed it and think it will be quite useful.	It was fun.	If it is not possible to get in the animal room, the lesson can still continue.	I wouldn't be able to wear the headset for the entire lessons, as it hurt my eyes a little. I would have to take small breaks throughout.		Simulators that could mimic in the field activities e.g. dog grooming.
I think it’s a really cool and interactive way to learn.	You get to experience things full on without having to actually look at the animal.	This could help us with learning as it could give people the experience of situations that we learn about but may not witness and it will also help learn anatomy and nursing as you can see a 3D model.	No.		I would add a anatomy class where they look at dogs and other animals that we learn in Biology and Health and Disease.

It is a useful way to learn as it allowed you to repeat the question if you got it wrong.	Learning how the animal room used to look, it also helped me learn information about the animals that I may not have known before.	Maybe questioning students the correct technique on how to clean out animals, this helps them learn if they are doing it incorrectly and also makes sure that it is done correctly.	As someone who uses glasses the vision was a little blurry, but got better as I used it more. I had a few issues with setting up the VR and issues during the experience whilst answering questions.	Overall the experience was fun and enjoyable.	Maybe it could be used in order to learn information for exam units as it is interactive, this will help students remember information.
I think using VR in education is a very good and inclusive idea as it can be used in many many ways. It could even help neurodivergent people learn in a more accessible way.	I learnt about some of the possible ways VR could be used in the future in schools and in the workplace as well as seeing how well it could be used to advertise our college.	An example I thought of for using VR in animal care is if someone cannot make it on a trip to a zoo for example, they could use a VR headset to connect to 360 degree cameras stationed around animal enclosures that many zoos have for their live videos on their websites and observe the animals through that.	If used for a long time it can start to cause a headache as well as not being great for your eyesight.	Nope	Not that I can think of right now.

Catering

Catering overview:

The catering department VR resource was created in a similar manner to animal care with a central position. One main difference was the view inside the walk in fridge, this acted as another area which the students could ‘visit’.

Catering use data:

- Average interaction time 9.44 minutes.
- A combination of level 1 and 2 students completed the project, totalling 11 students.
- Average percentage score across the data during the VR assessment was 78%.
- Average percentage score across the data in the delayed assessment was 79%.
- The above overall percentages were heavily impacted by the data of two students, but these students were kept in the data set to give an accurate representation. Both students have significant high needs and struggled navigating through the VR experiences. When taking the two students out of the data set the average percentage score across the data during the VR assessment was 95%, with the average percentage score for the delayed assessment also being 95%.
- Two students scored higher in the VR experience.
- Five students scored the same in both the VR experience and the delayed assessment.
- Four students scored higher in the delayed assessment.

Catering assessment comparison:

User	VR resource score (%)	Google form questionnaire score (%)

766186	100	100
767365	100	100
768710	93	100
770512	100	100
770518	0	16
770986	93	100
771517	100	100
774349	100	82
787424	0	0 (Not submitted)
790461	100	71
791572	71	100
Average percentage score	**78**	**79**

Catering student feedback: Due to the level of the students selected to take part in the pilot, it was decided that in order to get the best possible student feedback, focus groups would be carried out focused on a range of themes. This also enabled the catering teachers to probe students

in a way that would yield more detailed feedback. Three focus groups were completed in total, with four students in two focus groups, and three in another.

In terms of some of the feedback regarding VR, generally during the focus groups students were positive regarding VR, both in the pilot and future opportunities. One student commented that ‘I really like how easy it is to use...I feel it is a lot better for people like me who are visual learners or for people who suffer with dyslexia or people that struggle with reading and writing in general.’ Another student stated how learning in VR is really useful from a safety perspective, with the potential of VR helping students learn in VR, key safety features prior to moving into real-life environments; the student commented, ‘Learning how to cook and do stuff without the risk of getting hurt.’ This is especially salient in catering, especially for students who may be practising with new equipment and techniques for the first time. Another student commented that they had been able to ‘remember more things’ which was one of the underpinning reasons for investigating VR.

This was further endorsed by another student who commented in the focus group, ‘ (it) Sticks in your head. You can look around and can see the answers, it helped being in the kitchen that I know.’ This was extended by another student who added, ‘I would like to use VR to ‘learn’ in a new kitchen by being able to look around and find where equipment is stored. I feel I hold on to knowledge more than writing it, being able to visualise the scene enables me to picture the answer.’

A student commented that the experience would be improved through ‘being able to record voice answers into VR to submit the answers, rather than having to type, which was a little difficult.’ This is salient, as at the time of writing the options for talk to text and other modalities continues to develop at pace. In fact, this option is now available in the software used to devise the resources in this pilot. This further extends the accessible nature of assessment to students in these environments, and is another potential positive of using such assessment methods.

Interestingly, several students commented together that ‘a virtual tour when joining the course would be good.’, with another student adding, ‘...I think it would be good for orientation for new students who need to go into different areas/situations.’

A couple of students did raise concerns about ‘the time I could wear the headset’, and ‘motion sickness’, although the general consensus was positive regarding being in VR, with one student commenting that ‘I preferred the questions being on the screen in VR as they were less distracting, and it was good to follow the words with the hand controller/pointer.’

Finally, students did comment that, ‘I think it could improve attendance and engagement…’ with another adding, ‘It’s exciting for the future of practicing practical tasks.’

Carpentry and Joinery

Carpentry and Joinery overview:

The carpentry and joinery VR resource was created in more of a ‘tour’ style environment. This was due, in part, to the fact that the area was far larger than either of the other curriculum areas and a central VR image would not work. The students could move through the workshop and see various points which had key learning points built into them. They could also return to the previous position or to the start of the tour.

Carpentry and Joinery data:

- Average interaction time 8.04 minutes.
- A combination of level 1 and 2 students completed the project.
- A total of 16 students were used for the pilot, but the data of 14 is included due to two students withdrawing during the collection of data. The two students who could not complete the experience have been removed from the accumulated averages due to them not being able to complete the experience.
- The average percentage score during the VR assessment was 90%. - Six students achieved 100% in the assessment.

Carpentry and Joinery assessment comparison:

User	VR resource score (%)
581100	100

701627	100
766968	100
768497	93
771062	100
771642	100
772282	87
773741	73
776399	80
784131	80
784786	73
785570	100
787034	Not completed due to feeling claustrophobic
787127	87

787728	Not completed due to feeling claustrophobic
789641	80
Average percentage score	**90**

Carpentry and joinery student feedback: As with catering, and due to both the level and preferences of those who took part in the pilot, it was decided that in order to get the best possible student feedback, focus groups would be carried out focused on a range of themes. In total, two focus groups were completed, with four students in each focus group. Some of the key aspects of the analysis are below.

One student commented that, ‘I think virtual reality could be a really interesting and useful tool for learning about construction. It would allow us to practise building things without actually having to build them. I also think it would be a good way to learn about different techniques and methods, since we could see them in action in a virtual environment. I'm excited about using VR in education.’ Another student continued with the positive sentiment, ‘I think one of the main positives of using VR for construction would be that we could make mistakes without it being a big deal, in VR we could just start over and try again. I also think it would be a good way to learn about safety procedures, since we could practise them without actually being in danger.’ This sentiment was echoed across the sample (it was also commented on by a catering student in the previous section), for example, another student agreed, stating, ‘For example, we could use it to practise using different tools and equipment without actually having to use them in real life. This would be especially helpful for dangerous equipment. We could also use VR to simulate different things, like working on a construction site during bad weather.’ At the end of this discussion another student added, ‘I really can see the benefit of using it to learn in a safe environment, prior to moving into real-world situations.’ This narrative from the data is salient and offers another potential benefit of using VR in formative assessment, permitting students to make mistakes with a reduced cost, both in terms of finance and safety to students.

Other students commented that they were quite excited about the potential of VR from an engagement perspective, stating, ‘I think the biggest thing about using VR in education is that it would make learning more engaging and interesting.’ This was supported by another student who followed up with, ‘It would make learning more engaging and interactive, which would make it more fun and memorable. I hope we get to use VR soon!’

Students also agreed that the contextualisation of learning was a strength of using VR, highlighted by this quote during the discussions, ‘I also think it would be a good way to learn about things that are hard to visualise, like complex building structures.’ Another student added, ‘One thing I'm really excited about with using VR in construction is that we could learn about different building materials and techniques in a really immersive way. We could see how different materials interact with each other and how they hold up under different conditions.’

One student in one of the focus groups did highlight two key areas for consideration that are salient for implementation, ‘Personally, I think one of the negatives of using VR is that it can make me feel dizzy or disoriented. This might not be a problem for everyone, but it's something to consider. Another negative is that it might be hard to get used to using VR at first, especially if you've never used it before.’

Staff feedback

The staff involved in the VR project were asked for feedback (initials used in place of full names). PB is a member of the Digital eLearning team and has been involved in the creation and development of the VR resources with the lead teachers from the curriculum areas. The teaching staff are also listed, with GR and JH from catering, MC from carpentry and joinery, and TK from animal care.

Had you used VR or Thinglink before this project? If so how?

GR	No..
JH	I had some interactions with it before the project but nothing in depth.
PB	In my role as a member of the digital team, I've assisted both teachers and students in a range of VR projects. These projects have included virtual visits to destinations such as Stonehenge, the International Space Station, and rainforests. Additionally, I've contributed to the development of classroom materials utilising ThingLink.
MC	No I hadn't.
TK	Yes, to create resources for my lessons (Thinglink).

Did you feel confident using the resource?

GR	Yes.
JH	Yes.
PB	Yes.
MC	Yes.
TK	Yes.

Was it an easy process to get the students on to the VR set up?

GR	Yes.
JH	Yes.
PB	No.
MC	No.

TK	Yes.

Give a reason for this:

GR	Support from other staff helped.
JH	It was fairly straightforward to get the students set up as PB had done a good walkthrough presentation that we could do with the students. There were a few issues but I would say the process was easier rather than hard. After a few sessions I think the students would find it easier. Those students who had experience of VR devices at home found the process easier than those that don't.
PB	Setting up and charging each device individually was a challenging task, particularly without any management software in place. Moreover, our WIFI connectivity was not entirely reliable, which further compounded the difficulties we faced while trying to sign in the students.
MC	There were challenges as the technology/internet was slow and it can be difficult to direct students to a destination when you cannot see what they are looking at, as some will go off on a tangent.
TK	The students followed the instructions clearly, they all seemed comfortable. A few technical glitches but these were solved.

Do you feel that you had enough training on the VR equipment?

GR	Yes.
JH	No.
PB	Yes.
MC	No.
TK	Yes.

Did this impact the use of the resource with your class?

GR	Yes.
JH	Maybe.
PB	Yes.
MC	Yes.

TK	Yes.

Would you use VR again?

GR	Yes.
JH	Yes.
PB	Yes.
MC	Yes.
TK	Yes.

If you were to use VR again are there any aspects you would like to change?

GR	WiFi issues made use in some areas an issue.
JH	I would like to be able to have some dedicated CPD time with the E-learning team to use the resources and build up some experience and understanding of the process.
PB	My focus would be to enhance the device setup, management, and connectivity.
MC	Yes, I need to develop my own confidence first.
TK	I would like a more up to date version of the VR tour we did of the animal room, so I could use it for open evenings, school visits etc.

Any other thoughts?

GR	Overall this will become a very useful teaching tool.
JH	The training on the VR equipment question that I answered no to were basically due to work demands that didn't give me the time to spend with the E-learning team before the students had chance to experience the resource. I am keen to develop and build on the resources.
PB	Having witnessed the impact of VR on students, particularly those in our Inclusion program, I have observed a notable improvement in their confidence levels. VR has helped them overcome their anxiety, stress, and fear of the unknown. I strongly believe that if VR technology is utilised effectively, it can significantly transform the lives of these students, both inside and outside the classroom.

MC	To see in grid form what the students are looking at so we are able to direct them to where they should be.
TK	No.

Analysis

Student Assessment Performance

One of the main objectives of the pilot was to ascertain the impact of VR on assessment. To accomplish this in the pilot, students were set an assessment activity in VR that had a set number of questions and linked to an overall percentage. When looking at the data from the VR assessments, students in animal care scored an average of 92%, and an average of 86% in the delayed assessment administered after 24 hours through a Google Form. On further analysis, six students scored higher in the VR experience, six students scored the same in the VR and delayed experiences, and two students scored higher in the delayed assessment.

In catering, the data shows that the average percentage on the VR assessment was 78% and 79% on the delayed assessment. However, it should be noted that two students with high needs are included in the data, even though they could not complete the assessments. When their data is removed the percentage for both the VR experience and delayed assessment is 95%. The rationale for keeping the two students in the data is that it gives an accurate overview of the pilot, ensuring full transparency. For catering, two students scored higher in the VR experience, five students scored the same in both the VR experience and the delayed assessment and four students scored higher in the delayed assessment.

In carpentry and joinery, where data was only collected during the VR experience, the average score was 90%. Two students were removed from the data set due to not completing the assessment as they were feeling claustrophobic. Six students achieved 100% in the designed assessment.

The above data, from across the three curriculum areas suggest that VR has a positive impact on assessment. Research has previously shown this (Zhao et al, 2020), but this pilot has emphasised this in an applied setting. Students scored well on the VR assessment, with the average scores highlighting this. It confirms that students being able to learn in a simulated environment that contextualises questions and assessment is a positive of VR (Erolin, et al., 2019; Yammine & Violato, 2015), and this pilot certainly emphasises that. Too often, learning and assessment is not contextualised for students, especially students with lower levels of English, but VR has the potential to make the information more accessible for all students, as shown here. This option to make tasks more understandable due to the context questions are set, as opposed to a workbook that simply has words on a page, should be investigated further in the future.

Interestingly, and potentially the most salient aspect, is the assessment scores on the delayed assessment, which was administered after a further 24 hours of completion of the VR assessment. In the two areas this was completed, the animal care overall percentage only decreased by 6pp to 86%, with catering actually increasing by 1pp. This is a key finding and certainly should be researched further in the future. The ability for students to recall information to build detailed schema and long-term knowledge is vital in the learning process, and the data in this pilot suggests that VR can support this. Research for many years has indicated the importance of study strategies to enhance learning through desirable difficulties (Bjork & Bjork, 2011; Bjork & Bjork, 2014) by utilising approaches for retrieval practices and practice testing (Dunlosky et al, 2013). Even dating back to the well established research conducted by Hermann Ebbinghaus over a hundred and thirty years ago, the retention of information significantly decreases every passing day if it is not revisited. The data here would suggest that VR is an excellent way to reduce the forgetting of newly acquired information.

The data that was not changed or manipulated to give a true representation does show that four students did struggle and have problems in the experiences. Firstly, two high needs catering students did struggle in both the VR experience and then with the subsequent delayed assessment. Two students in carpentry and joinery felt disoriented and claustrophobic so stopped. Although a small number of the data set, these issues do indicate that the use of VR has to be carefully managed, with a recommendation to ensure inductions are completed for all VR users, so these issues can be identified early.

Student Feedback

Another key objective was to discuss the views of students on their experiences with VR throughout the pilot. Student feedback was gathered through the most appropriate method for the respective groups, with the animal care students preferring to complete a questionnaire, and catering and carpentry and joinery giving feedback through focus groups.

Feedback from across the range of participants highlighted many positive points that give further hope for the use of VR in the future, especially to support with assessment. The questionnaire responses from the animal care students had comments such as: ‘I think it has a lot of potential and could really alter the education system for the better. I think it gives students who struggle with the writing and focusing aspect of learning a chance to express their knowledge in a new way, one which suits them much better.’ Another student added, ‘ I think using VR in education is a very good and inclusive idea as it can be used in many many ways. It could even help neurodivergent people learn in a more accessible way.’ Across the data set it could be deduced that the VR brought a fun element to students’ assessment, and students enjoyed this.

During the focus groups, catering students and carpentry and joinery students also had many positive points to raise regarding their experiences. Comments indicated across the data set that students enjoyed the experiences and felt it helped make assessments more

accessible, and along with supporting engagement, it was really useful to be assessed and then have the chance to practise more in the experience, which is not always the case in practical environments. Interestingly, this was discussed in both the focus groups with catering students and carpentry and joinery students. This may go some way to reducing the high stakes feel of assessments, with students benefiting from being assessed in VR and utilising the feedback to fill in the gaps in their learning.

Across the feedback from all the curriculum areas detailed in the results section, it is evident that engagement is certainly a positive in the feedback from students. However, it is also clear that this has been contextualised in many cases to learning and assessment. A great example of this is the student in carpentry and joinery who commented, ‘I also think it would be a good way to learn about things that are hard to visualise, like complex building structures.’ What is evident is that students are not only discussing engagement, and even in some aspects the fun of using VR, they are in most cases thinking about how VR could help them develop their key knowledge, skills and behaviours through VR, which is a key point. It is apparent that further research is required to build on the obvious notion of greater student engagement and constructivist learning (Ferriter, 2016; Hu-Au & Lee, 2017), but it is clear that opportunities to build content with high fidelity learning experiences to support students to practise and become fluent in a given domain, as shown in this pilot, offers optimism for the use of VR in education.

Throughout the student feedback, the main concerns were headaches and discomfort when in the VR experiences, but this was only a small proportion of the sample. It should be acknowledged that research has suggested this previously (Kim & Shin, 2021; Chang, Kim & Yoo, 2020) and institutions looking to invest in VR should research the range of additionalities that are available to enhance the experience and comfort for users. Closely linked to the above, the requirement to ensure a full induction is completed for users is also a key priority, and comments in both the questionnaire and focus groups did state this. Finally, further research is required on the optimal length of VR experiences.

Staff Feedback

The overall feedback from staff was very positive, the difference it made to the students' engagement was tangible. Through observation analysis and talking to the staff after the sessions it was clear that more training and time with the VR hardware was needed to make them more comfortable using the resource, and this was also evident through the response to the short survey completed. Although this was planned for and enacted during the pilot, evidently this aspect can still be further enhanced and is a useful finding for any institution in the future. A plethora of research has indicated that staff self efficacy, knowledge and confidence is vital for the successful implementation of educational technology (Compeau & Higgins, 1995; Shea, 2007; Zhen, et al., 2008)

There was also discussion about what is next and all staff were excited to see what else is possible and were discussing developing more materials for the future. These could also include virtual tours and orientation materials for students coming into college or maybe going onto placements.

A final observational aspect of the staff feedback was the need to have a desire from staff to develop an aspect of assessment through VR. The staff in this pilot were proactive in identifying an area of their curriculum that they wanted to enhance and this was key. They all utilised their knowledge of their particular curriculum, their pedagogical knowledge to design assessments, and then worked with the digital team to engender these. Staff engagement is certainly a key aspect for successful implementation.

Conclusion, Recommendations & Next Steps

This pilot aimed to investigate the use of VR on assessment. This was underpinned by three key objectives:

- Analyse the impact of VR on the performance of students in assessments
- Evaluate the impact VR can have to support the long-term learning of knowledge, skills and behaviours through when tested through a delayed assessment
- Discuss the views of both staff and students on their experiences of VR and how it could enhance assessment in the future

In relation to the first two objectives, the data in the pilot suggests that students perform very well in assessments in VR, and following the delayed assessment completed in two curriculum areas, VR could be useful for enhancing knowledge retention. The average score in the VR assessment in animal care was 92%, only reducing by 6pp in the delayed assessment administered 24 hours later. In catering the data shows that the average percentage on the VR assessment was 78% and 79% on the delayed assessment. However, it should be noted that two students with high needs were included in the data, even though they could not complete the assessments. When their data is removed the percentage for both the VR experience and delayed assessment is 95%. This again emphasises the success during the VR assessment, but also the retention of information assessed 24 hours later. This is a crucial finding. Finally, in carpentry and joinery, where data was only collected during the VR experience, the average score was 90%.

The final objective was concerned with gathering feedback on VR from both staff and students. In terms of students, where data was collected through a questionnaire (animal care), and focus groups (catering and carpentry and joinery) much of the feedback was positive. The data collected indicated students enjoyed the experiences and saw the potential for how it could be used in the future. They also intimated that it was engaging and enabled them to learn content virtually prior to doing it practically, thus enabling the chance to practise and repeat skills. The main consideration was concerned with the discomfort when wearing the VR headsets, although this was a minority of students.

Finally, staff feedback was also positive, with those included in the pilot keen to build more experiences through VR, as they were impressed with the difference it made to students.

In conclusion, the pilot has intimated that students perform well when assessment is completed in VR. Moreover, information and knowledge retention could be a real positive of using VR assessments. Both staff and students were positive about the use of VR, and how it could be developed in the future.

The pilot has also given opportunities to reflect on the wider aspects for successfully implementing VR. Recommendations are offered below:

- Successful implementation has to be led from a curriculum teacher/team who have reflected on their curriculum content and want to enhance an aspect of their assessments to support students. The staff involved in this pilot had really bought into the opportunities afforded by VR, and that is key. In many respects, it is their knowledge of pedagogy and assessment that drives the process, with the technology then 'bringing to life' their ideas. In addition, curriculum staff have that in-depth knowledge of their content, and can utilise VR in the most appropriate way, for example, to support students to learn in a safe environment which was discussed in the student data.

- The support from digital specialists is of paramount importance. In this pilot, the Digital and E-Learning Team at the college were excellent in working with both curriculum staff and students.
- Inductions and training for both staff and students is vital for success. Within the pilot we had planned for this, but reflecting on the data, it is clear that it is an element we could improve in the future.
- From a technical perspective, any institution should make sure they have the desired set up, including networks, software and hardware to implement VR effectively.
- Finally, an institution should utilise students when researching the best VR kit in terms of comfort and adaptability.

This pilot has highlighted some of the positive ways that VR can support in the development of learning programmes through assessment. This pilot can now be built on at the college, but also across the sector. Other next steps should consider the wider benefits and uses of VR and how it could be utilised in a variety of ways to enhance the student experience. Good examples of these are the utilisation of VR to create campus tours for new students, or the orientation of certain resources in a college, for example a practical laboratory. These steps extend VR beyond assessment but offer excellent opportunities to enhance processes and procedures. As with all successful integration of technology, it needs to be driven by the needs of an institution and reviewed at regular intervals to ascertain impact.

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