Questionnaire 1

1. Do you have any experience in a molecular research diagnostics lab? Y/N

2. How much experience with Virtual Reality (VR) technology do you have?

    I have a great deal of experience with VR technology.
    I frequently use VR.
    I occasionally use VR.
    I rarely use VR.
    I have never used VR.

3. If you have used Virtual Reality (VR) technology before, can you tell us what equipment you have used? Please select all that apply.

    Google Cardboard
    Samsung Gear VR
    Other version of VR which involved a mobile phone in a box
    Oculus Go
    Oculus Quest/Quest 2
    Google Daydream
    HTC Vive Focus
    Another version of VR which was standalone (no PC or console was required to run the VR system)
    Playstation VR
    Oculus Rift/Rift S
    HTC Vive/Vive Pro
    HTC ViveCosmos
    Pico Neo/Neo 2
    Lenovo/Dell/HP
    Samsung Odyssey
    Other version of VR that was Tethered (the VR system had to be connected to a PC or console to run)

4. How much experience with video gaming do you have?
    I have a great deal of experience with video games.
    I occasionally play video games.
    I rarely play video games.
    I never play video games.

5. How comfortable are you using computer technology beyond basic word-processing, web-browsing and playing video games?

    I am very comfortable.
    I am moderately comfortable.
    I am moderately uncomfortable.
    I am very uncomfortable.

6. What is your gender?

Male
Female
Non-binary
Gender-fluid
Other
Prefer not to say

7. What is your degree group?

Anatomy
Physiology
Pharmacology
Human Biology
Neuroscience
Microbiology/Immunology
Zoology/Marine and Freshwater Biology
Genetics/MCB/Biochemistry

8. If you had to choose, what is your social class?

Upper class
Upper middle class
Middle class
Lower middle class
Upper working class
Working class

9. Do any of your parents have a university degree?

Yes
No
Not sure

10. How confident would you feel if asked to perform a qPCR experiment independently?

Extremely confident
Confident
Somewhat confident
Neutral
Somewhat not confident
Not confident
Not confident at all

11. How confident would you be performing a qPCR experiment independently?

Extremely confident
Confident
Somewhat confident
Neutral
Somewhat not confident
Not confident
Not confident at all

12. How confident do you feel about analysing qPCR results independently?

Extremely confident
Confident
Somewhat confident
Neutral
Somewhat not confident
Not confident
Not confident at all

13. How confident would you feel working aseptically using a lamina flow hood?

Extremely confident
Confident
Somewhat confident
Neutral
Somewhat not confident
Not confident
Not confident at all

14. Place these stages of setting up a pipette in the correct order:
    a. Push plunger to the first stop
    b. Push plunger to the second stop
    c. Dispense liquid
    d. Aspirate liquid
    e. Pick up a tip
    f. Place tip into liquid
    g. Eject tip

15. What is the function of SYBR green in a qPCR?

    a. To detect DNA bands during gel electrophoresis
    b. To bind to double stranded DNA and fluoresce
    c. To bind to single stranded DNA and fluoresce
    d. To allow the polymerase to add nucleotides
    e. I don't know

16. Why is it important to set up a Master Mix?
    a. To reduce pipetting error
    b. To minimise the risk of contamination
    c. It is convenient and saves time
    d. All of the above
    e. I don't know

17. What steps can we take to prevent contamination when setting up a qPCR?

    a. Clean surfaces and equipment before and after with 70% ethanol
    b. Setting up each stage on the bench
    c. Handling multiple samples simultaneously

d. I don’t know

18. What are the key advantages to using qPCR over traditional PCR - tick all the apply

Sensitive
Rapid
High through-put
Cheaper
Quantification of RNA
I am unsure

19. The higher the cycle threshold (Ct-value) the greater the starting quantity of DNA present in the sample. This statement is:

True
False
I don't know

Questionnaire 2a

1. Were you able to watch the video of the Virtual Reality lesson? Y/N

2. Please tell us on what type of device you viewed the Virtual Reality lesson.

   A computer monitor
   A laptop
   A mobile phone
   A tablet
   Other

3. How confident are you in your understanding of quantitative PCR (qPCR)?

   Extremely confident
   Confident
   Somewhat confident
   Neutral
   Somewhat not confident
   Not confident
   Not confident at all

4. How confident would you be performing a qPCR experiment independently?

   Extremely confident
   Confident
   Somewhat confident
   Neutral
   Somewhat not confident
   Not confident
   Not confident at all

5. How confident do you feel about analysing qPCR results independently?

   Extremely confident
   Confident
   Somewhat confident
   Neutral
   Somewhat not confident
   Not confident
   Not confident at all

6. How confident would you feel working aseptically using a lamina flow hood?

   Extremely confident
   Confident
   Somewhat confident
   Neutral
   Somewhat not confident
   Not confident
   Not confident at all

7. Place these stages of setting up a pipette in the correct order:
    a. Push plunger to the first stop
    b. Push plunger to the second stop
    c. Dispense liquid
    d. Aspirate liquid
    e. Pick up a tip
    f. Place tip into liquid
    g. Eject tip

8. What is the function of SYBR green in a qPCR?

    a. To detect DNA bands during gel electrophoresis
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    c. To bind to single stranded DNA and fluoresce
    d. To allow the polymerase to add nucleotides
    e. I don't know

9. Why is it important to set up a Master Mix?
    a. To reduce pipetting error
    b. To minimise the risk of contamination
    c. It is convenient and saves time
    d. All of the above
    e. I don't know

10. What steps can we take to prevent contamination when setting up a qPCR?

    a. Clean surfaces and equipment before and after with 70% ethanol
    b. Setting up each stage on the bench
    c. Handling multiple samples simultaneously
    d. I don't know

11. What are the key advantages to using qPCR over traditional PCR - tick all the apply

    Sensitive
    Rapid
    High through-put
    Cheaper
    Quantification of RNA
    I am unsure

12. The higher the cycle threshold (Ct-value) the greater the starting quantity of DNA present in the sample. This statement is:

    True
    False
    I don't know

13. To what extent did you understand the qPCR process demonstrated in Virtual Reality (VR)?

    Completely understood
    Understood
    Somewhat understood
    Neutral
    Somewhat did not understand
    Did not understand
    Completely did not understand

14. How present did you feel in the Virtual Reality VR qPCR scenario that you were engaging with?

    Fully present
    Present
    Somewhat present
    Neutral
    Somewhat not present
    Not present
    Fully not present

15. To what extent did you feel like you were in the lab during the lesson?

    I fully felt like I was in the lab
    I felt like I was in the lab to a considerable degree
    I somewhat felt like I was in the lab
    I felt neutral about whether I was in the lab or not in the lab
    I somewhat felt like I was not in the lab
    I felt like I wasn't in the lab to a considerable degree
    I fully felt like I was not in the lab

16. To what extent did you feel like you were being demonstrated to live in a lab environment?

    I fully felt like I was being demonstrated to live in a lab environment
    I felt like I was being demonstrated to live in a lab environment to a considerable extent
    I somewhat felt like I was being demonstrated to live in a lab environment
    I felt neutral
    I somewhat felt like I was not being demonstrated to live in a lab environment
    I felt like I was not being demonstrated to live in a lab environment to a considerable extent
    I fully felt like I was not being demonstrated to live in a lab environment

17. To what extent did the teaching method improve your understanding of qPCR?

    The teaching method had a strongly positive effect on my understanding of qPCR
    The teaching method had a positive effect on my understanding of qPCR
    The teaching method had a somewhat positive effect on my understanding of qPCR

The teaching method had no effect on my understanding of qPCR
The teaching method had a somewhat negative effect on my understanding of qPCR
The teaching method had a negative effect on my understanding of qPCR
The teaching method had a strongly negative effect on my understanding of qPCR

18. How likely would you be to recommend this method of learning to another student?

    Very likely
    Likely
    Somewhat likely
    Neither likely nor unlikely
    Somewhat unlikely
    Unlikely
    Very unlikely

19. On a scale of 1-10, with 1 being not enjoyable and 10 being very enjoyable, where would you place the Molecular Methods online lab book (including the Virtual Reality (VR) lesson)?

    10 - Very enjoyable
    9
    8
    7
    6
    5
    4
    3
    2
    1 - Not enjoyable

20. How would you describe your experience of the lesson (including the Virtual Reality (VR) lesson)? [open text box]

21. Did you experience any feelings of nausea or dizziness during the lesson?

    Yes
    No
    Not sure

22. On a scale of 1-10, with 1 being very nauseous and 10 being not at all nauseous, how nauseous did you feel during the lesson?

    10 - Not at all nauseous
    9
    8
    7
    6

5
4
3
2
1 – Very nauseous

23. Did you experience any negative side-effects during the lesson? If so, please explain what these were. [open text box]

24. Do you have any additional comments on Virtual Reality (VR) teaching? [open text box]

Questionnaire 2b

1. How confident are you in your understanding of quantitative PCR (qPCR)?

   Extremely confident
   Confident
   Somewhat confident
   Neutral
   Somewhat not confident
   Not confident
   Not confident at all

2. How confident would you be performing a qPCR experiment independently?

   Extremely confident
   Confident
   Somewhat confident
   Neutral
   Somewhat not confident
   Not confident
   Not confident at all

3. How confident do you feel about analysing qPCR results independently?

   Extremely confident
   Confident
   Somewhat confident
   Neutral
   Somewhat not confident
   Not confident
   Not confident at all

4. How confident would you feel working aseptically using a lamina flow hood?

   Extremely confident
   Confident
   Somewhat confident
   Neutral
   Somewhat not confident
   Not confident
   Not confident at all

5. Place these stages of setting up a pipette in the correct order:
   a. Push plunger to the first stop
   b. Push plunger to the second stop
   c. Dispense liquid
   d. Aspirate liquid
   e. Pick up a tip

f. Place tip into liquid

g. Eject tip

6. What is the function of SYBR green in a qPCR?

    a. To detect DNA bands during gel electrophoresis
    b. To bind to double stranded DNA and fluoresce
    c. To bind to single stranded DNA and fluoresce
    d. To allow the polymerase to add nucleotides
    e. I don't know

7. Why is it important to set up a Master Mix?
    a. To reduce pipetting error
    b. To minimise the risk of contamination
    c. It is convenient and saves time
    d. All of the above
    e. I don't know

8. What steps can we take to prevent contamination when setting up a qPCR?

    a. Clean surfaces and equipment before and after with 70% ethanol
    b. Setting up each stage on the bench
    c. Handling multiple samples simultaneously
    d. I don't know

9. What are the key advantages to using qPCR over traditional PCR - tick all the apply

    Sensitive
    Rapid
    High through-put
    Cheaper
    Quantification of RNA
    I am unsure

10. The higher the cycle threshold (Ct-value) the greater the starting quantity of DNA present in the sample. This statement is:

    True
    False
    I don't know

11. To what extent did you understand the qPCR process demonstrated by reading through the document/via the qPCR 2D animated Learning Science demonstrations?

    I was completely able to understand the process
    I was able to understand the process to a considerable degree
    I was somewhat able to understand the process

Neutral
I was somewhat unable to understand the process
I was unable to understand the process to a considerable degree
I was completely unable to understand the process

12. How present did you feel in the online lab manual qPCR scenario that you were engaging with?

    Fully present
    Present
    Somewhat present
    Neutral
    Somewhat not present
    Not present
    Fully not present

13. To what extent did you feel like you were in the lab during the lesson?

    I fully felt like I was in the lab
    I felt like I was in the lab to a considerable degree
    I somewhat felt like I was in the lab
    I felt neutral about whether I was in the lab or not in the lab
    I somewhat felt like I was not in the lab
    I felt like I wasn't in the lab to a considerable degree
    I fully felt like I was not in the lab

14. To what extent did you feel like you were being demonstrated to live in a lab environment?

    I fully felt like I was being demonstrated to live in a lab environment
    I felt like I was being demonstrated to live in a lab environment to a considerable extent
    I somewhat felt like I was being demonstrated to live in a lab environment
    I felt neutral
    I somewhat felt like I was not being demonstrated to live in a lab environment
    I felt like I was not being demonstrated to live in a lab environment to a considerable extent
    I fully felt like I was not being demonstrated to live in a lab environment

15. To what extent did the teaching method improve your understanding of qPCR?

    The teaching method had a strongly positive effect on my understanding of qPCR
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    The teaching method had a somewhat positive effect on my understanding of qPCR
    The teaching method had no effect on my understanding of qPCR
    The teaching method had a somewhat negative effect on my understanding of qPCR
    The teaching method had a negative effect on my understanding of qPCR
    The teaching method had a strongly negative effect on my understanding of qPCR

16. How likely would you be to recommend this method of learning to another student?

    Very likely
    Likely
    Somewhat likely
    Neither likely nor unlikely
    Somewhat unlikely
    Unlikely
    Very unlikely

17. On a scale of 1-10, with 1 being not enjoyable and 10 being very enjoyable, where would you place the Molecular Methods online lab book?

    10 - Very enjoyable
    9
    8
    7
    6
    5
    4
    3
    2
    1 - Not enjoyable

18. How would you describe your experience of the lesson? [open text box]

19. Did you experience any feelings of nausea or dizziness during the lesson?

    Yes
    No
    Not sure

20. On a scale of 1-10, with 1 being very nauseous and 10 being not at all nauseous, how nauseous did you feel during the lesson?

    10 - Not at all nauseous
    9
    8
    7
    6
    5
    4
    3
    2
    1 – Very nauseous

21. Did you experience any negative side-effects during the lesson? If so, please explain what these were. [open text box]

Questionnaire 3

1. Were you able to view the Virtual Reality lesson? Y/N

2. Please tell us on what type of device you viewed the Virtual Reality lesson.

   A computer monitor
   A laptop
   A mobile phone
   A tablet
   Other

3. Was the lesson with the VR experience more enjoyable than the lesson without it? Explain your answer. [open text box]

4. Do you think you learned more in the VR lesson than the lesson without VR?
   Yes
   No
   I'm not sure

5. Did you feel more like you were being demonstrated io live in a lab environment in the VR lesson than in the lesson without it?
   Yes
   No
   I'm not sure

6. Which method of learning are you more likely to recommend (VR or no VR)? [open text box]

7. Did you feel any difference in terms of nausea in the VR lesson compared to the lab book lesson?

   Yes- more nausea with VR
   Yes- less nausea with VR
   No difference
   I'm not sure

8. Do you have any additional comments on Virtual Reality (VR) teaching? [open text box]

Focus group questions

- Background question: How much experience of VR do you have?
- We are curious about how much the VR demonstration helped you to understand the qPCR process. Do you feel like the VR demonstration helped you understand what to do in the lab? How so?
- After watching the qPCR VR demonstration do you think you would be more confident working in a real lab? How so?
- Comparing the qPCR VR demonstration to, say, the workbook exercises, in what ways was the VR demonstration better or worse than the workbook?
- Was the VR demonstration enjoyable and interesting?

Supplementary File 3 Hyperlinks

Disease Diagnostic Laboratory voice-over walk through:

https://www.edify.ac/industry-solutions/biosciences-edify-training-solution-disease-diagnostics-laboratory

2D ‘Learning Science’ qPCR simulation:

https://www.learnsci.com/products/labsims

Supplemental Materials 3 (S3): Descriptive statistics for variables included in OLS regression models

Variable: Female

	Freq.	Percent
Men (0)	68	80.00
Non-Binary (0.5)	1	1.18
Female (1)	16	18.82
N	85	

Variable: Working Class

	Freq.	Percent
Other (0)	56	65.88
Working Class (1)	29	34.12
N	85	

Variable: A parent with a university degree

	Freq.	Percent
None (0)	31	36.47
One or more parents with a university degree (1)	54	63.53
N	85	

Variable: Previous laboratory experience

	Freq.	Percent
No (0)	72	84.71
Yes (1)	13	15.29
N	85	

Variable: Previous VR experience

	Freq.	Percent
Never (1)	58	68.24
Rarely (2)	25	29.42
Occasionally (3)	2	2.35
A Great Deal (4)	0	0
N	85	

Mean = 1.34
S.D. = 0.52

Variable: Previous video gaming experience

	Freq.	Percent
Never (1)	13	15.29
Rarely (2)	32	37.65
Occasionally (3)	27	31.76
A Great Deal (4)	13	15.29
N	85	

Mean = 2.47
S.D. = 0.93