

Exploring the shift to online open-book final exams: The impact on question types and the experiences of students and academics

Comparing question type allocations between equivalent semesters

Table S1. Pearson's chi-squared test values for the percentage of marks allocated to different question types between Semester 1 and Semester 2 of 2019-2020, 2020-2021, and 2019-2021 for first-, second- and third-year exams. * = significant p-value < 0.05. ^a = large effect sizes

| | 2019-2020 Semester 1 | | | 2019-2020 Semester 2 | | |
|--------------------|----------------------|--------------------|----|----------------------|--------------------|----|
| | p-value | Cramer's V | df | p-value | Cramer's V | df |
| First-year | <0.001* | 0.301 ^a | 8 | <0.001* | 0.583 ^a | 7 |
| Second-year | <0.001* | 0.464 ^a | 8 | <0.001* | 0.395 ^a | 8 |
| Third-year | <0.001* | 0.346 ^a | 6 | <0.001* | 0.314 ^a | 7 |
| | 2020-2021 Semester 1 | | | 2020-2021 Semester 2 | | |
| | p-value | Cramer's V | df | p-value | Cramer's V | df |
| First-year | <0.001* | 0.233 ^a | 7 | <0.001* | 0.312 ^a | 8 |
| Second-year | 0.560 | 0.110 | 6 | 0.487 | 0.125 | 7 |
| Third-year | <0.001* | 0.415 ^a | 9 | <0.001* | 0.230 ^a | 8 |
| | 2019-2021 Semester 1 | | | 2019-2021 Semester 2 | | |
| | p-value | Cramer's V | df | p-value | Cramer's V | df |
| First-year | <0.001* | 0.355 ^a | 8 | <0.001* | 0.581 ^a | 8 |
| Second-year | <0.001* | 0.512 ^a | 9 | <0.001* | 0.421 ^a | 9 |
| Third-year | <0.001* | 0.416 ^a | 9 | <0.001* | 0.486 | 7 |

Table S2. Pearson's chi-squared test values for the percentage of marks allocated to different Bloom's taxonomy levels between Semester 1 and Semester 2 of 2019-2020, and 2020-2021 for first-, second- and third-year exams. * = significant p-value < 0.05. ^a = large effect sizes, ^b = medium effect sizes.

| | 2019-2020 Semester 1 | | | 2019-2020 Semester 2 | | |
|--------------------|----------------------|--------------------|----|----------------------|--------------------|----|
| | p-value | Cramer's V | df | p-value | Cramer's V | df |
| First-year | 0.394 | 0.077 | 3 | 0.004* | 0.170 ^b | 4 |
| Second-year | <0.001* | 0.295 ^a | 3 | 0.055 | 0.149 | 4 |

| | | | | | | |
|-----------------------------|---------|--------------------|----|-----------------------------|--------------------|----|
| Third-year | <0.001* | 0.317 ^a | 4 | 0.221 | 0.092 | 5 |
| 2020-2021 Semester 1 | | | | 2020-2021 Semester 2 | | |
| | p-value | Cramer's V | df | p-value | Cramer's V | df |
| First-year | <0.001* | 0.216 ^b | 3 | 0.141 | 0.128 | 4 |
| Second-year | 0.258 | 0.100 | 3 | 0.307 | 0.109 | 4 |
| Third-year | <0.001* | 0.361 ^a | 5 | <0.001* | 0.373 ^a | 5 |
| 2019-2021 Semester 1 | | | | 2019-2021 Semester 2 | | |
| | p-value | Cramer's V | df | p-value | Cramer's V | df |
| First-year | <0.001* | 0.190 ^b | 3 | 0.786 | 0.058 | 4 |
| Second-year | <0.001* | 0.305 ^a | 3 | 0.037 | 0.158 | 4 |
| Third-year | <0.001* | 0.331 ^a | 5 | <0.001* | 0.341 | 5 |

Table S3. Pearson's chi-squared test values for the percentage of marks allocated to lower and higher order questions between Semester 1 and Semester 2 of 2019-2020 and 2020-2021 for first-, second- and third-year exams. * = significant p-value < 0.05. Most Cramer's V values indicate a small effect size; ^b = medium effect sizes.

| | | | | | | |
|-----------------------------|---------|--------------------|----|-----------------------------|------------|----|
| 2019-2020 Semester 1 | | | | 2019-2020 Semester 2 | | |
| | p-value | Cramer's V | df | p-value | Cramer's V | df |
| First-year | 0.327 | 0.043 | 1 | <0.001* | 0.160 | 1 |
| Second-year | <0.001* | 0.262 | 1 | 0.245 | 0.058 | 1 |
| Third-year | 0.769 | 0.010 | 1 | 0.783 | 0.010 | 1 |
| 2020-2021 Semester 1 | | | | 2020-2021 Semester 2 | | |
| | p-value | Cramer's V | df | p-value | Cramer's V | df |
| First-year | 0.280 | 0.053 | 1 | 0.015 | 0.118 | 1 |
| Second-year | 0.372 | 0.045 | 1 | 0.036 | 0.103 | 1 |
| Third-year | 0.431 | 0.030 | 1 | <0.001* | 0.224 | 1 |
| 2019-2021 Semester 1 | | | | 2019-2021 Semester 2 | | |
| | p-value | Cramer's V | df | p-value | Cramer's V | df |
| First-year | 0.033 | 0.095 | 1 | 0.300 | 0.046 | 1 |
| Second-year | <0.001* | 0.302 ^b | 1 | 0.420 | 0.045 | 1 |
| Third-year | 0.300 | 0.040 | 1 | <0.001* | 0.215 | 1 |

Interview guides for students taking Type P and/or Type O exams

Guiding questions:

1. What were the experiences of students when completing either paper-based or electronic exams in 2019, 2020 and 2021?
 - a. For students that have done both a paper-based and an online exam, how did the delivery of exams being online affect:
 - i. Their emotional/mental state while taking the exam?
 - ii. The length of the student's responses/answers?
 - iii. The structure of their responses?
 - iv. The amount of time spent on different types of questions?
 - v. Their time management?
 - b. For students that have only done online exams, what was their perceived experience of them?
 - i. How was their emotional/mental state while taking the exam?
 - ii. How much time was time spent on different types of questions?
 - iii. How did they structure their answers?
 - iv. How did they manage their time?
 - c. What impact, if any, did the use of proctoring services (such as Proctor U) have on the students' experiences during online exams?
 - d. How were the students' experience of online exams affected by the COVID-19 pandemic?

Consent process

Thank you for your willingness to participate in this research study (Titled: Exploring the impact on student exam responses when changing from paper-based to electronic exams). My name is [name], and I am a [professional title].

Today, I'm interested in your perceptions and experiences of exams delivered online or on paper. The questions that I'm going to ask today are predominately about:

- the experiences you had whilst taking paper-based or online exams
- your techniques and strategies while answering exam questions

After that, I'll ask you about any general experiences during the COVID-19 pandemic and how they may have affected your exam experience.

If you are uncomfortable with any questions that are raised, you may simply choose not to answer the specific question, or you may choose to leave the online meeting. What we discuss today will be potentially published as part of a research report or in a journal publication. Your identity or any information that could identify you as a participant will remain confidential. Additionally, if you raise the identity of any other individuals (e.g.

your peers or the teaching staff), this will also be redacted from future publication of this discussion. Please also note that the audio of this Zoom interview will be recorded for further analysis. Please keep your video off during the recording of this Zoom interview. If you are happy to proceed, please let me know verbally now. Thank you!

Interview questions

Before we get into the main questions, I just had a few questions about yourself:

1. How many years have you been enrolled in your current degree?
2. What is your major?
3. Think back to your chemistry exams at USYD,
 - a. When did you first take a chemistry exam?
 - b. How many chemistry exams did you take? For which units?
 - c. Were they online or paper-based? Which ones were paper-based?
 - d. Were they proctored or not proctored?

Paper-based and online exams

Since you've done both paper-based and online exams, let's talk about these experiences.

- How was your experience with online exams? Did you prefer it over paper-based exams? Why or why not?
- What feelings did you have while taking an online exam? Was it different to when you took a paper-based exam?
- How did you manage your time during an online exam? Was this different to when you did an exam on paper?
 - Did you complete the exam chronologically?
- Considering that the online exams were open-book, how much time did you spend looking through your notes during the exam?

I'd like you to now think about the types of questions you had in the online and paper-based exams. So think of, for example, your multiple choice, short answer or calculation questions.

- In an online exam, did you spend more, less or about the same amount of time on each type of question? Why did you do so?
- What types of questions, if any, did you prefer to have in an online exam? Why?
 - How is this different to your paper-based exams?
- (If not already raised) Did you have drawing questions in your online exam?
 - What do you think about having no drawing questions in an online chemistry exam?
 - Would you prefer to have drawing questions?
- (If not already raised) Did you encounter calculation questions in your online exams?

- Do you prefer completing them online or on paper? Why?
- Did you type up all your working out? Was this preferable?

I'm now going to move to looking at how you structured your answers to exam questions.

- Compared to a paper-based exam, were your typed answers longer or shorter? Why?
- Did you type in full sentences, or in dot points or short phrases? Why did you do so?
- Did you think about formatting your answers e.g. using superscript or subscript? Why?

Online-exams only

Let's talk about your experience with online exams.

- How would you describe your experience with online exams?
- What feelings did you have while taking an online exam?
- How did you manage your time during an online exam?
 - Did you complete the exam chronologically?
- Considering that the online exams were open-book, how much time did you spend looking through your notes during the exam?

I'd like you to now think about the types of questions you had in the online and paper-based exams. So think of, for example, your multiple choice, short answer or calculation questions.

- Did you spend more, less or about the same amount of time on each type of question? Why did you do so?
- What do you think about having drop down box questions in an online exam?
- (If not already raised) Did you have drawing questions in your online exam?
 - What do you think about having no drawing questions in an online chemistry exam?
 - Would you prefer to have drawing questions?
- (If not already raised) Did you encounter calculation questions in your online exams?
 - Do you prefer completing them online or on paper? Why?
 - Did you type up all your working out? Was this preferable?

I'm now going to move to looking at how you structured your answers to exam questions.

- Did you type in full sentences, or in dot points or short phrases? Why did you do so?
- Did you think about formatting your answers e.g. using superscript or subscript? Why?

Proctored exams

Now I'd like you to think back to when you had a proctored exam.

- What impact, if any, did the use of Proctor U have on your experiences during online exams?

Personal life/challenges due to pandemic

Finally, if you're comfortable, was there anything you wanted to add about how the pandemic affected your online exam experience or ability to prepare for an exam? This may include study spaces, distractions, technological challenges, etc. Thank you for your time!

Interview guides for academics

Guiding questions:

1. What were the experiences of academics within the Faculty of Science (School of Chemistry) when writing exams during 2019-2021?
 - a. What impact, if any, did the online delivery of exams have on:
 - i. The types of questions they included?
 - ii. The abstractness of the questions included?
 - iii. The allocation of marks to different types of questions?
 - iv. The level of thinking required by the questions included?
 - b. What impact, if any, did the proctoring of exams have on the questions written?
2. What were the experiences of academics within the Faculty of Science (School of Chemistry) when marking exams during 2019-2021?
 - a. What impact, if any, did the online delivery of exams have on how final exams were marked?
3. What were the academics' perceived experiences of students doing online exams?
 - a. According to academics, how did online exams affect:
 - i. The students' emotional/mental state while taking the exam?
 - ii. The amount of time spent on different types of questions?
 - iii. How they structured their answers?
 - iv. Their time management?
4. What lessons have academics learnt after writing online exams during 2019-2020?
 - a. Can they provide any suggestions or advice for the future?
 - b. How would they change question writing for the future?

Consent process

Thank you for your willingness to participate in this research study (Titled: Exploring the impact on student exam responses when changing from paper-based to electronic exams). My name is [name], and I am a [professional title].

Today, I'm interested in your experiences of writing online exam questions during the COVID-19 pandemic. The questions that I'm going to ask today are predominately about:

- the experiences you had while writing online exams
- your perceptions on what students experienced when taking online exams
- any lessons learnt

If you are uncomfortable with any questions that are raised, you may simply choose not to answer the specific question, or you may choose to leave the online meeting. What we discuss today will be potentially published as part of a research report or in a journal publication. Your identity or any information that could identify you as a participant will remain confidential. Additionally, if you raise the identity of any other individuals (e.g. your peers or the teaching staff), this will also be redacted from future publication of this discussion. Please also note that the audio of this Zoom interview will be recorded for further analysis. Please keep your video off during the recording of this Zoom interview. If you are happy to proceed, please let me know verbally now. Thank you!

Interview questions

Before we get into the main questions, I just had a few questions about yourselves:

1. How long have you been writing exams for?
2. Have you written online exams or quizzes before 2019?
3. Have you written exams for first-year, second-year and/or third-year chemistry units?

So first, I'd like to ask about your experience while writing online exams.

- How would you describe your experiences of writing an online exam, especially compared to a paper-based exam?
- What were the main types of questions that you included in your online exams?
 - Were these different to the types in your paper-based exams?
 - Why did you include these types of questions in an online exam?
- How did you allocate your marks to different types of questions in online exams, compared to paper-based exams?
- Non-abstract questions would use real-life examples and data, while abstract questions include generalisations, such as a general energy profile diagram, and made-up examples and data.

- How abstract do you think were the questions you wrote for your online exams?
- A lower level of thinking would require students to recognise and recall facts, or understand and explain something. A higher level of thinking would ask for the application, evaluation or synthesis of ideas.
 - Do you think the questions you wrote for your online exams required a higher or lower level of thinking compared to paper-based exams? Why or why not?
- What impact, if any, did the proctoring of exams have on the questions you wrote?

Next, I'd like to talk about your experiences marking exams.

- How would you describe your experience of marking online exams? Did you prefer to mark online or paper-based exams? Why?

So next up, I would like to ask you about your thoughts on student experiences of taking online exams.

- Do you think the online delivery of exams affected students' emotional or mental state during the exam? Why do you think so?
- How much time do you think students allocated to each type of question?
- How do you think students structured their answers? In full sentences or dot points/short phrases?
- What do you think about the depth/amount of content included in their answers?
- How well or poorly do you think students managed their time in online exams? Why?

I'd like to now show you some results that we found from our previous study on first year chemistry exam questions.

- In terms of types of questions, we found that fill in the blank, short answer and drop-down box questions were favoured in online exams, with more marks being allocated towards them. What do you think about this result? Why do you think this was the case?
- We found that the majority of questions included in our 2020-2021 online exams were not abstract and were indeed, similar to the 2019 exam allocations. What do you think about this?
- There appeared to be a trend where the questions in online exams were more often found to require a lower order of thinking compared to paper-based exams. What do you think about this? Why do you think this was the case?

Finally, having written online exams, what lessons have you learnt during this time? How would you change the way you write question in the future?

Thank you for your time!