Are They Actually Helpful?
Student Perceptions on the Impact of Pre-Lecture Quizzes on Their Learning

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Introduction

Students generally perceive chemistry courses as difficult because these courses often involve reconstructions of meaning through abstract topics, whilst introducing specialised language and nomenclature (Millar, 1991; Woldeamanuel, Atagana & Engida, 2014). Traditionally, these units are typically taught by implementing didactic lecture-based approaches (Lund & Stains, 2015), however, many educators deem these approaches as ineffective when compared to active learning models (Jungst, Wiersema & Licklider, 2003). The active learning model is a teaching strategy where the student is a partner in the learning process rather than a passive participant. The teacher is seen as a facilitator who guides the learning process, but it is ultimately the student who plays a dynamic and energetic role in their own education (Petress, 2008).

To make space for active learning in class, flipped learning has grown in popularity. Flipped learning has been formalised as a pedagogical approach where students are presented with material prior to class, which allows formal class time to be reserved for active learning tasks (Seery, 2015), like problem sheets or student-led discussions. The benefits of the flipped learning model lie in its ability to reduce the load on working memory (Karaca & Ocak, 2017), which is a major consideration of Cognitive Load Theory.

Cognitive Load Theory

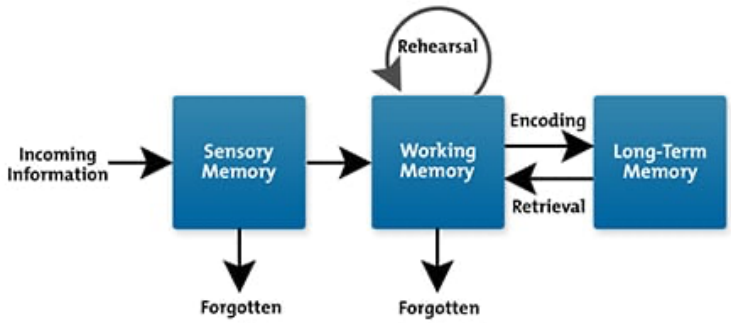

Figure 1: Information processing model (Atkinson & Shifrin 1968, as reproduced by MindTools, n.d.)

As seen in Figure 1, working memory stores intermediate information being used, rehearsed, and manipulated in the planning and execution of cognitive tasks (Atkinson & Shifrin, 1968;

Barak & Tsodyks, 2014). This information can then be stored in one's long-term memory which contains the vast information gained over their life (Cowan, 2014). According to Cognitive Load Theory (CLT), only small amounts of novel information can be processed in working memory at any given time (Sweller, 2011) due to the limited capacity of our working memory (Miller, 1956; Hulme et. al., 1995; Service, 1998). If this capacity is exceeded, students risk not understanding content, resulting in new information not effectively being stored in one's long-term memory, i.e., a cognitive overload (Martin, 2016).

Subsequently, a key benefit of the flipped learning model is that it allows content to be pre-taught to students to free up working memory in class time, easing cognitive load (Sirhan & Reid, 2001). Pre-lecture resources alone have been shown to ameliorate cognitive load as new concepts are introduced prior to lectures (Seery & Donnelly, 2011).

The Benefits of Pre-Lecture Resources

The benefits of pre-lectures resources' reduction on cognitive load is evident in literature. Seery and Donnelly (2011) found that pre-lecture resources in an introductory chemistry course reduced in-lecture cognitive load by pre-teaching key concepts. This was seen by the significant grade-improvements of students without prior chemistry knowledge to a point where there was no distinction between the marks of students with and without prior knowledge. In a similar vein, Harrison (2017) found in a marketing course which additionally featured in-class active learning elements, that there was a 6.5% proportional increase in final exam marks when pre-lecture quizzes were implemented.

Other studies have focused on students' perceptions of pre-lecture resources, findings that students deem these resources beneficial for teaching effectiveness (Harjoto, 2016), student satisfaction (Das et al., 2019), and exam preparation (Narloch, Garbin & Turnage, 2006).

Based on the literature surrounding the benefits of pre-lecture resources, the University of Sydney's (USyd) School of Chemistry (Chem) adopted a partially flipped learning model for all first-year chemistry courses as part of a curricula renewal in 2015, wherein, lectures still contain portions of didactic teaching.

Partially Flipped Learning Model at USyd Chem

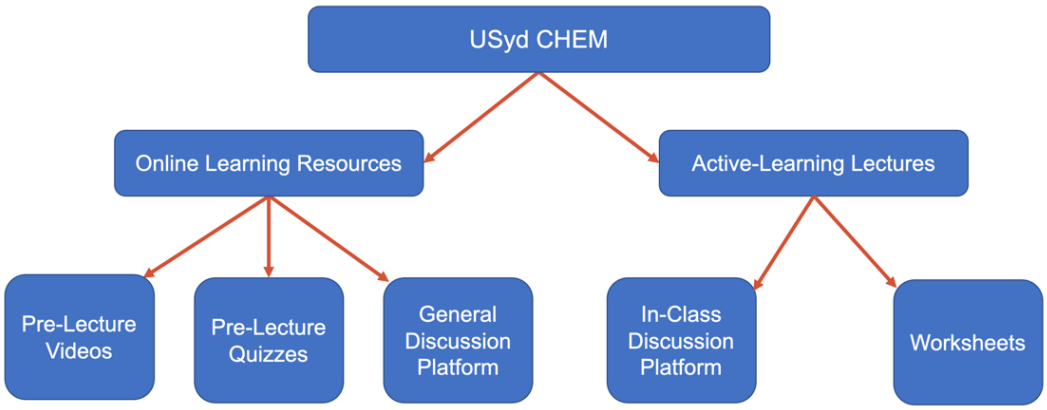

Figure 2: University of Sydney's School of Chemistry first and second year partially flipped learning model (reproduced from Bokosmaty, Bridgeman & Muir, 2019)

The aforementioned partially flipped learning model for first- and second-year courses is depicted in Figure 2. Notably, this model included the addition of pre-lecture videos and quizzes to pre-expose student to content to reduce in-lecture cognitive load. There are one-two pre-lecture videos for each teaching week of an approximately combined ten-minute duration. This is followed by a short unlimited attempt quiz run on the course management system (Canvas in this case). Students are incentivised to engage in this pre-lecture content as the quizzes from each week contribute to a combined ten percent of a student's grade. It is intended that students complete the quiz before the first lecture (out of three) in each week, yet, up until 2021, they still had a fortnight to attempt the quiz, which meant that some students may choose to complete the quiz *after* the live lectures. Herein lay the first research question of this study, when do students *actually* complete the pre-lecture quizzes when given the freedom to choose?

Additionally, previous research by Boskosmaty, Bridgerman and Muir (2019) from USyd Chem investigated the effect of this partially flipped learning model when introduced for the semester one, first year chemistry courses. By analysing data from before and after the model implmentation (data from 2009 to 2016), notable insights included:

- the number of students who received distinction/high distinction level grades remained unchanged or increased, with a range of a 0-31% proportional increase.
- the number of students who failed decreased or remained unchanged, with a range of a 0-7% proportional decrease.
- a 7-24% increase in positive student perceptions on the quality of learning resources.
- student perceptions on teaching quality increased or decreased for different course streams (see Appendix A).

However, whilst their investigation focused on the overall effect of the partially flipped learning model, it is unknown which intervention (per Figure 2) – pre-lecture materials or in-class active learning – had this impact. This is of particular interest as USyd's third year chemistry courses solely utilise active learning, not pre-lecture resources. Additionally, Bokosmaty et. al. (2019) gathered student perceptions using the university led unit of study survey, which is more centred around broad data collection.

To address the issues noted above, this research involved the use of semi-structured interviews on second-year students (students with 1.5 years of experience with the partially flipped learning model) and third-year students (students with 2 years of experience with the model, followed by the removal of pre-lecture resources). Thematic analysis was then performed to explore student perceptions on the impact of the presence (or absence) of pre-lecture quizzes and videos on their learning.

Hence, this research sought to explore the following research questions:

1) What are the proportions of first-year students completing pre-lecture quizzes before the timetabled first lecture of a given week when given the choice of when to complete these tasks?
2) What are the second- and third- year students' perceptions of the pre-lecture videos and quizzes in terms of the impact on their learning?

Methods

Theoretical Framework

The theoretical framework underpinning Research Question 2 was Phenomenography. Phenomenography is defined as "the different ways in which people experience, interpret, understand, perceive or conceptualise a certain phenomenon or aspect of reality" (Bodner & Orgill, 2007, p. 128). In accordance with Bodner and Orgill's (2007) methodological guidelines for phenomenographic studies, the main form of data collection in this study was a result of semi-structured interviews.

Whilst the nature of Research Question 1 does not fall under phenomenography as it does not explore the different ways in which people experience a given phenomenon (Bodner & Orgill, 2007), it still provides contextual insight into when students historically attempted the pre-lecture quizzes.

Pre-Quiz Attempt Analysis

Research Question 1 was investigated by analysing when students in the mainstream second semester first-year chemistry course in 2019 (N = 179) and 2020 (N = 124) completed the pre-lecture quizzes for each respective week.

Anonymised data from Canvas was downloaded to allow for the tracking of the quiz completion dates of students. As it was possible for a student to attempt the quizzes unlimited times, only the timestamp of their first attempt was considered. However, it is important to note that most students (around 81%) had their first and last attempt within a few hours of one another. Additionally, only data after the census date (the last date to drop a unit without academic or financial consequence) was considered to account for students who do not contribute to quiz completions in subsequent weeks. The mean proportion of students who completed quizzes prior to lectures and those who left the quiz until the closing weekend were calculated and reported.

Interview Data Collection

Ethics approval was sought and obtained by the University of Sydney Human Research Ethics Committee (project number: 2021/676).

Students enrolled in second- or third-year Chemistry courses were notified via an email from the Student Relationship Engagement System (SRES). Students were offered a $20 gift voucher in exchange for their participation in the short interviews which lasted around thirty minutes. These interviews were conducted by two student interviewers and in accordance with the ethics approval, the supervising researchers who maintain positions of leadership at USyd Chem never knew the identity of student volunteers. Further, students were asked to reaffirm their consent before the interview questions were asked (see Appendix B). Three second year and seven third year students volunteered to participate in this study.

The interviews themselves were semi-structured. The interview protocol provided general questions the interviewer would ask (see Appendix C), with the added ability to ask further questions depending on the interviewee's responses. Questions broadly covered areas such as the demographics of a student (e.g. major/s being completed, previous marks, previous

enrolment) alongside their perceptions on the impact of the pre-lecture quizzes and videos. The interviews were performed on Zoom where only the audio was recorded, and then anonymised transcripts were produced.

Interview Analysis

Per Bodner and Orgill (2007), the commonly used approach in the analysis of semi-structured interviews in phenomenographic studies involve thematic analysis. In this study, the student researcher and a single supervisor independently analysed the same single transcript, where the specific themes mentioned by students were assigned codes (coded) using the NVivo software package. After this, the student researcher compared the themes, modifying and discussing them as needed. The student interviewer then independently conducted the remaining thematic analyses. Whilst undergoing the analysis, and after all transcripts had their themes encoded, similar sub-themes were combined into larger parent themes.

Limitations

The present study's sample is not representative of entire second- and third- year cohorts in USyd Chem. Seeing the grades of student volunteers, there is a clear bias towards high achieving students amongst the second-year sample, and even the more balanced third-year sample is still similarly biased, (Appendix D). The sample is also not representative given its small size.

A further limitation is that the interviewers were students without any prior interviewing experience and so question delivery could at times have been unintentionally biased. Any interview questions and answers where this occurred to a serious extent were discarded.

Lastly, there is uncertainty surrounding the longitudinal effect of the COVID-19 virus on the results of this study. At the time of interviewing students (October 2021), the state of New South Wales was in lockdown (the state USyd resides), meaning students were solely learning remotely. Additionally, many international students have been learning remotely for two full years.

Results and Discussions

When did students complete their quizzes?

In line with Research Question 1, Table 1 summarises when students tended to complete their pre-lecture quizzes.

Table 1: Mean proportion of students which completed their first quiz attempt at different times.

Year	Time of Quiz Attempt	Mean Proportion
2019	Before first lecture	$12.2 \pm 1.1\%$
2020	Before first lecture	$13.4 \pm 4.0\%$
2019	Weekend before the quiz closes	$27.4 \pm 0.5\%$
2020	Weekend before the quiz closes	$35.9 \pm 3.3\%$

From Table 1 we see that the raw values in 2019 and 2020 slightly differ, with much more variability of around 3-4% evident in 2020. Regardless, the overarching narrative is consistent that only a very small proportion of students (around 13%) would have their first quiz attempt before the first lecture of the corresponding week. Clearly, very few students attempted the pre-lecture quizzes as intended (i.e., before the first lecture of the week). Furthermore, roughly 30% of students left their first attempt until the weekend before the quiz closed. However, it is important to consider that as lectures are recorded, students may still be completing the quizzes before lectures, they just aren't watching the lectures during the timetabled session. Nonetheless, given the extreme values in Table 1, it appears likely that a large portion of students are not completing the pre-lecture resources as intended.

As these findings contradict the intention of introducing these pre-lecture resources in the first place, it raises questions on the efficacy of these resources. This dilemma will be further explored in relation to Research Question 2.

What were the student perceptions of the impact of the pre-lecture quizzes and videos?

The phenomenography theoretical framework was used as the lens to analyse the themes students raised when asked their thoughts on the impact of the pre-lecture quizzes and videos. The beneficial/positive impacts noted are provided in Table 2, which also indicates how often a theme was raised by second- or third- year students.

Table 2: Key themes noted in the student interviews when considering the beneficial/positive impacts that arise from the pre-lecture quizzes and videos. Other themes raised are provided in Appendix E.

Theme (number of second years who raised the theme, number of third years who raised the theme)	**Representative quote(s)**
Impact through pre-exposure to content (2,6)	"I would be … exposed to the [lecture] contents a little bit earlier." OR "…it would have been harder to understand [the lectures], like what was going on".
Impact in understanding and practicing the fundamentals (2,5)	"…they were just good resources for making sure that the foundation is in… [and to] make sure you know how to do this very basic thing for this unit of study."
Impact in using quizzes as a revision tool (0,4)	"…the more revision side … now that I'm forced to actually answer questions that forces me to actually think about it deeply, and sort of solidify my understanding of it…" OR "…it's like just to make sure to test your understanding of what you've learned in the last week... so that a lot was just revision…" OR

	"…across the chemistry school … one of the biggest struggles … in general is that lack of practice."
Impact as an assessment preparation/revision tool (1,1)	"I would compile them [the quizzes] [and] do them as practice questions for my exams."

From the data shown, it is apparent that most interviewees perceived the quizzes impact in providing pre-exposure to content (8) and helping them to understand and practise the fundamentals of a given unit or topic (7). Notably, these two themes fit with the intentions of introducing these pre-lecture resources (Bokosmaty et. al., 2019). However, the 'impact through pre-exposure to content' theme does seem contradictory to the findings in Research Question 1 that a very small proportion of students did in fact complete the pre-lecture quizzes pre-lecture. Whilst uncertainty remains about these contrary findings, this is possibly a result of students engaging in the quizzes before watching the recording of the lectures, or a result of the biased sample. This is emphasised by the fact that 50% of interviewees claimed to consistently engage with these resources within a few days of them being released, compared to the approximated 13% when assuming students watch lectures at their schedule time (from Research Question 1).

Another commonly occurring impact was that students (4) identified the quizzes as a revision tool. That being said, all of these students occasionally or always completed the pre-lecture quizzes after the first lecture. Hence, revision here would occasionally refer to revising the lecturers of the current week. However, similar to revision, some students (2) identified the quizzes' impact as an assessment preparation/revision tool, where one student identified (refer to the last quote in Table 2) turning back to the quizzes for revision before completing assessments. Regardless, students were turning to the pre-lecture content for revision, as one student felt this was their only option because of a perceived lack of practice and revision resources provided by USyd Chem. This shows that whilst the intended implementation of these pre-lecture resources was to reduce cognitive load by pre-teaching content, students perceive the impacts of these quizzes as much farther reaching.

Whilst many beneficial impacts were raised, Table 3 collates key themes raised where students perceived no or reduced impacts for these pre-lecture resources.

Table 3: Key themes noted in the student interviews when considering no or reduced impacts for the pre-lecture quizzes and videos. Other themes raised are provided in Appendix F.

Theme (number of second years who raised the theme, number of third years who raised the theme)	**Representative quote(s)**
Not impactful for assessment preparation (1,2)	"[I] don't think they're the best for [assessment] preparation[.] … they … [weren't] like the in-semester test nor were they like the finally exam, So I guess … [they] weren't as helpful for assessment based."

Impact reduced through semester (0,2)	"…I feel like as they wore on especially in the last few weeks they were still like talking about new things, it was just that the impact was less because you've like you know throughout the semester you like [gained] a good deal of knowledge." OR "…it's only towards the end of semester for some reason, um, as the work gets more difficult, it's explained less sufficiently…"
Impact is reduced for third lecture (0,1)	"…if you had three lectures in the week, … especially the last one, it was like … usually sort of … related, but not as heavily related to the pre lecture quizzes…"

Interestingly, by comparing Tables 2 and 3, there are conflicting perceptions from students. For example, four students mentioned that the quizzes were impactful for revision, whilst two students mentioned that they were not. These conflicting perceptions of where the quiz and video impact/s lie represents the complexity of phenomenographical research, and how opposing perceptions can present. However, whilst such oppositions exist, overall, all interviewees mentioned some positive impact from the pre-lecture videos and/or quizzes. Rather, only where this impact lay was contentious.

Some students mentioned (2) that they perceived a reduction in the impact of pre-lecture videos and quizzes as the semester progressed. Reasons included that they had already gained a "good deal of knowledge", and so the quizzes weren't teaching them anything new, while one student hinted towards a potential quality decrease in the videos. It was surprising that no student hinted towards this being due to increases in fatigue, which has been shown to increase through the semester (Shim et. al, 2019).

One student also perceived a diminishing impact of pre-lecture resources for the third (and last) lecture of the week. This is rationalised by the difficulty for educators to fit copious amounts of new content into these resources, whilst ensuring each video's duration does not drastically increase. By extrapolating findings by Guo, Kim and Rubin (2014), a potential solution could be adding an extra short video (0-3 minutes) on content relevant to lecture later in the week. Per Guo et. al., this is where student engagement is highest, however, future research is warranted as to whether this hypothesised addition would be effective at USyd Chem.

What were the student perceptions of the impact of the pre-lecture quizzes and videos not being in third year chemistry courses?

Second- and third- year students were asked for their perceptions on the impact on their learning of the pre-lecture resources not being a part of their third-year chemistry units. Table 4 tabulates all themes raised where students supported the addition of the pre-lecture videos and quizzes into third-year chemistry.

Table 4: All themes noted in the student interviews of students who miss or want the pre-lecture videos and/or quizzes back, and how having these resources back would impact their learning.

Theme (number of second years who raised the theme, number of third years who raised the theme)	**Representative quote(s)**
Third year quizzes desired to practice content (1,3)	"…yeah overall, general loss not having as much practice in third year."
General comments on missing third-year quizzes (0,3)	"I would 100% perfect much prefer to have them included in the like unit, outline or whatever." OR "… and taking those away I don't really, I don't know why they would be…"
Third year quizzes desired for pre-exposure to new content (0,2)	"I think they [the pre-lecture quizzes] really help you to sort of engage with the material and have a familiarity with the material before you're actually going to learn it. And I think that becomes particularly important in the third year…"
Non-assessable pre-lecture quizzes desired in third year (0,1)	"I think I would like them … but only if they weren't assessable."

Observing Table 4, overall, most students interviewed (7) desired third-year pre-lecture videos and or quizzes; whether it's for practice content (4), pre-exposure to new content (3), or even just general comments on missing the quizzes (3).

One student raised that they would rather 'non-assessable pre-lecture' quizzes as they had concerns over adding additional summative assessment tasks to their already busy third year schedule. However, it is worthy to note that implementing non-assessable quizzes does transgress literature which states how adding a small weighting (i.e., the quiz contributes a small portion to a student's final grade) drastically improves the frequency the quizzes are engaged with (Evans, Kensington-Miller & Novak, 2017).

Thus, based off the student perceptions, most students would prefer these resources to be added into third-year chemistry units. This is strengthened when considering the themes raised in Table 5, which reveals the negative perception of a lack of pre-lecture quiz and video access in third-year learning.

Table 5: All themes noted in the student interviews where students display the negatives of not having the pre-lecture videos and or quizzes in their partially flipped learning model.

Theme (number of second years who raised the theme, number of third years who raised the theme)	**Representative quote(s)**
Lack of quizzes in third year detrimental to their self-perceived learning (0,4)	"…[third year] was definitely harder, but I don't know if that's just because the content was harder, but I think it [not having the quizzes] probably had an impact" OR "I guess sometimes it can be quite disengaging for my learning because I don't really understand what they're saying, and so it's just kind of sitting there and then you have to go through the lecture slides again." OR "I think it just makes it very difficult to understand what they're expecting us to understand, from the content."
Motivational decrease not having quizzes in third year (0,1)	"I think I've definitely been less motivated to revise weekly content, particularly because there's not a necessity too"
Lack in third year makes progress harder to judge (0,1)	"…it's definitely made … understanding your progress a little bit more muddier because you know you don't have like an 8 out 10 or 9 out of 10 to refer to saying like I understand this week's topic…"

In Table 5, four third-year students identified that the quizzes removal was 'detrimental to their self-perceived learning'. From the corresponding representative quotes, we see students felt "disengaged" as the pre-lecture quizzes did not provide pre-exposure to new content and did not make explicit what teaching staff were "expecting [students] to understand." Additionally, one student perceived a motivational decrease when the quizzes were removed, as well as another student perceiving the lack of quizzes as making it harder to judge their learning progress.

Finally, Table 6 displays the only theme raised where three students thought the pre-lecture quizzes were not as necessary in third-year chemistry.

Table 6: The single theme raised where students felt that third year pre-lecture resources are not as necessary in third-year chemistry.

Theme (number of second years who raised the theme, number of third years who raised the theme)	Representative quote(s)
Maturity of third year makes quizzes not necessary (1,2)	"That being said, I like I'm sort of more prepared now to ask or to do the independent research my self before going into lectures … I'm able to go look for that, those resources myself and prepare myself for the lectures. So it's sort of like I'm doing my own pre-lecture work… so I don't think it's necessary, but it would be still helpful." OR "…I feel like at third year, I feel like myself I understand like how well I'm coping with the topic… so at this stage I feel like not having them is fine … but, it would have been… useful [having third-year pre-lecture quizzes], just not as useful as first or second [year chemistry]."

Students (3) perceived that pre-lecture resources were not necessary because of the learning maturity that has resulted from their years of education, allowing them to self-check their understanding. Though, whilst these students don't believe they are not as necessary, they would still prefer them given the choice, they just do not perceive them as useful as in first- or second-year chemistry.

Conclusions

This study sought to investigate student perceptions of the impact of pre-lecture videos and quizzes as part of the first- and second- year chemistry partially flipped learning model. However, first Research Question 1 was explored to first contextualise the time of quiz attempts within a one-fortnight submission period.

Research Question 1:

> What are the proportions of first-year students completing the pre-lecture quizzes before the timetabled first lecture of a given week when students were given the choice of when to complete these tasks?

The data discussed found that approximately 13% of students in a first-year cohort were completing the quizzes before the first timetabled lecture, with around 30% of students leaving it until the last weekend of the fortnight. There is, however, some uncertainty surrounding these values, especially since it is possible for a student to engage with these resources prior to watching a recorded lecture later than the scheduled live version. Regardless, it still appeared a large number of students were not engaging in the resources at the intended time, raising questions surrounding the efficacy of the pre-lecture quizzes in ameliorating cognitive load.

This led to Research Question 2 to investigate the student perceptions on the impact of pre-lecture quizzes and videos

Research Question 2:

> What are the second- and third- year students' perceptions of the pre-lecture videos and quizzes in terms of the impact on their learning?

This question was investigated by semi-structured interviews with three second year and seven third year student volunteers. Many positive impacts of the pre-lecture resources were raised, such as pre-exposing students to lecture content, positively impacting their understanding and practice of fundamentals, and further impacting as a revision tool. Whilst the intentions of the quizzes content were to ameliorate cognitive load through providing pre-exposure to content (Bokosmaty et. al, 2019), students found the impacts much farther reaching.

Additionally, the interviewees were asked for their perceptions of the impact of the pre-lecture quizzes and videos not being a part of third year chemistry units. It was found that students perceived no pre-lecture resources as detrimental to their self-perceived learning, as well as having ramifications on their motivation and understanding on their progress through the unit. Given the choice, most students interviewed would prefer pre-lecture resources added into third year chemistry units.

Future Directions

From the interviews, most students would prefer pre-lecture videos and quizzes included into third-year chemistry units. Future directions could involve implementing a partially flipped learning model in third-year chemistry, whilst balancing the student perceptions raised in this paper with findings from literature such as the importance of quizzes being assigned a small weighting to incentivise student engagement. If a model is implemented, further interviews should be conducted to reassess student perceptions of this newly implemented model.

Further, literature demonstrates the benefits of a partially flipped learning model in reducing cognitive load (Seery & Donnelly, 2011; Harrison, 2017). However, the large set of themes raised regarding the impact of the quizzes, combined with the low proportion of students completing the quizzes before the lectures (as evident in Research Question 1), means that perhaps the impact of these quizzes is more significant in, for example, being a revision tool. This coincides with a change in 2021 semester 2 for some first-year chemistry course, where instead of pre-lecture quizzes, students were given post-lecture quizzes. Future research could involve comparing these findings with students doing the new post-lecture quizzes, to investigate how their perception on the impacts of the quizzes compare.

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Appendices

Appendix A

Different Chemistry Course Streams

Bokosmaty et. al. (2019) explained how there are three different chemistry courses students could enrol in (during 2015-16) depending on their high-school chemistry backgrounds. These courses include:

- The *fundamentals stream* for students with no prior high-school chemistry background.
- *Mainstream* for students with a sound background in high-school chemistry.
- *Advanced stream* for students with an exceptional background in high-school chemistry.

When looking at student perceptions of teaching quality, fundamentals and mainstream students noted a 7% increase, whilst student in the advanced stream noted a 22% decrease.

Appendix B

In-interview consent process, created by Stephen George-Williams (one of the supervising academics).

"Thank you for your willingness to participate in this research study (Titled: Student perceptions of weekly lecture quizzes). My name is (name), and I am a (professional title).

Today, I'm interested in your perceptions on the weekly lecture quizzes that you have been completing as part of your chemistry studies. The questions that I'm going to ask today are predominately about:

- Your history with chemistry and your interest in it,
- Previous performance and your enrolment,
- Perception of the weekly quizzes both in terms of how you accessed them and how well they were integrated in your learning.

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.

<Student gives or does not give consent here>

Thank you!"

Appendix C

Interview protocol/questions, created by Stephen George-Williams (one of the supervising academics).

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

1. What degree program and units are you enrolled in and why?
2. Why did you choose to enrol in chemistry and what is your prior experience with it?
3. How do you feel you are progressing in chemistry? What about in your other subjects as well?
    a. If you feel comfortable, do you mind telling me how you performed in your previous CHEM units?
    b. How are you feeling this semester?

I am now going to consult a list of prompts to help guide our discussion:

- When I refer to the weekly lecture quizzes in our CHEM1/2 units do you know what I'm talking about?
    - (if no) I'm referring to the canvas quizzes that you were required to complete each week either before or after your lectures for 10% of your total grade. You had unlimited attempts and they were typically linked with a short video.
    - Do/Did you find them easy to find? Why or why not?
    - When did you tend to complete them? Why?
    - Do/Did you find them easy or hard? Why?
        - What marks did you tend to get after they had closed?
    - How many times did you tend to complete them? Why?

- What impact, if any, did you think these weekly lecture quizzes had on your learning?
    - (If pre) did you find they impacted your learning during lectures
        - (If an impact is noted) In what way did they cause this impact?

- What relevance do you think the quizzes had with respect to the lecture and tutorial content?

- (CHEM3 students only) What impact, if any, has having no weekly lecture quizzes in your CHEM3 units had on your learning?
    - Given the choice, would you have preferred to have them included in the CHEM3 units? Why/why not?

I have one final question - Is there anything you would like to add before we finish?

Thank you for your time!

Appendix D

Grade distribution of students interviewed

The University of Sydney uses a grading system as outlined in Table D.1, where a university grade descriptor relates to each performance band.

Table D.1: Grading system at the University of Sydney as reproduced from the Coursework Policy 2014 regulations document.

Grade	Description	Mark Range	Use
HD	High Distinction	85 – 100	To be awarded to students who, in their performance in assessment tasks, demonstrate the learning outcomes for the unit at an exceptional standard as defined by grade descriptors or exemplars established by the faculty.
DI	Distinction	75 – less than 85	To be awarded to students who, in their performance in assessment tasks, demonstrate the learning outcomes for the unit at a very high standard as defined by grade descriptors or exemplars established by the faculty.
CR	Credit	65 – less than 75	To be awarded to students who, in their performance in assessment tasks, demonstrate the learning outcomes for the unit at a good standard as defined by grade descriptors or exemplars established by the faculty.
PS	Pass	50 – less than 65	To be awarded to students who, in their performance in assessment tasks, demonstrate the learning outcomes for the unit at an acceptable standard as defined by grade descriptors or exemplars established by the faculty.
FA	Fail	0 – less than 50	To be awarded to students who, in their performance in assessment tasks, fail to demonstrate the learning outcomes for the unit at an acceptable standard established by the faculty. This grade, with corresponding mark, should also be used in cases where a student fails

Table D.2 shows the grades students interviewed received in their most recent chemistry unit.

Table D.2: Grades of students interviewed in their most recent chemistry unit of study. Where two chemistry units were studied in the same semester, the waiting is equally distributed amongst the bands the student achieved.

Grade	Second Year Students (N = 3)	Third Year Students (N = 7)
HD	0	1
D	2.5	3
C	0.5	1.5
P	0	0.5
F	0	1

Appendix E

Remaining themes considering beneficial/positive impacts for the pre-lecture quizzes and videos.

Table E.1: Remaining themes noted in the student interviews when considering the beneficial/positive impacts that arise from the pre-lecture quizzes and videos.

Theme (number of second years who raised the theme, number of third years who raised the theme)	Representative quote(s)
Impact in quizzes deadline installing structure (2,1)	"I think it would be a lot easier to fall behind on lectures because … there's nothing necessarily due for that week so you don't have the same drive…"
Impact in allowing class time to ask teaching staff specific questions on content they struggled with in the quiz (0,2)	"If there were topics that I didn't understand, I had an opportunity to try and learn them myself first and then if I was struggling still, I'd have questions ready for the lectures that I could ask the lecturer."

Appendix F

Remaining themes considering no or reduced impacts for the pre-lecture quizzes and videos.

Table F.1: Remaining themes noted in the student interviews when considering no or reduced impacts for the pre-lecture quizzes and videos.

Theme (number of second years who raised the theme, number of third years who raised the theme)	Representative quote(s)

Not impactful for introducing new topics (0,2)	"… and for second year …did I learn anything from them? I think nah, not to a huge degree…"
Not impactful for revision (0,2)	"I don't really use them for assessment practice or like revision."
Impact depends on quiz and video (1,0)	"…[the impact] depends on the individual quizzes and the videos that accompany it…"