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What Style of Tutorial Solution Video Should We Make?

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ABSTRACT

CONTEXT

As tertiary education moves to incorporate more blended learning, the use of worked problem solution videos is becoming more widespread. Several studies have started to investigate the role that these videos can play in student learning and the factors that influence student engagement, such as video length, style and content. There are conflicting findings as to what style is most useful. There is still significant research required to be able to provide educators with information regarding best practice for creating these videos.

PURPOSE OR GOAL

This research project seeks to assess the relative value of three video styles of worked problem solution videos, with respect to student learning. It seeks to investigate student's perception of their engagement with the material and whether there is a unified option, or if different video styles better suit learners with different preferences. This research will enable other educators to make informed decisions regarding future development of worked problem solution videos.

APPROACH OR METHODOLOGY/METHODS

A total of 173 tutorial question solution videos were provided to second year undergraduate students in three different styles, in addition to written solutions. These styles were lecture style, voiceover style and handwritten (Khan Academy style). Early in semester, video solutions were only provided in one style for a given question. Later in semester, some questions had multiple styles of video solution available. A survey was administered, probing students' viewing habits and preferences.

OUTCOMES

The preliminary results show that there is no one preferred style of video. Students preferred either the lecture style or handwritten style, and further investigation is required to tease out a single preferred style. Students reported choosing to watch the solutions videos for a range of reasons, and sometimes had conflicting opinions.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

This study shows that students find tutorial question video solutions useful, and there are a range of preference as to the style of video which is best. This is in line with previous work on the topic; different studies from literature show different preferences from students. Content creators should make videos in the style that best works for them, when subject matter, time and cost are taken into consideration.

KEYWORDS
Engagement, video styles.

Introduction

Engineering education has been increasingly adopting the use of online videos in subject delivery. Online videos have been characterised by Kay (2012) to adopt three distinct teaching approaches: receptive viewing, created video podcasts and problem solving. Kay (2012) found receptive viewing, such as content delivery videos commonly used in flipped classroom deliveries, represented most video types reported in literature. Some studies have previously reported using problem solving video types in other disciplines (Crippen & Earl, 2004; Loomes et al., 2002) and in engineering (Dart, Cunningham-Nelson, Dawes, 2020; Sart, Pickering, Dawes, 2020; Dart, 2020).

Many studies have investigated the role that online videos play in student learning and the influencing design factors for student engagement. Fyfield et al. (2019) has categorised research into educational videos as falling into three categories: investigating platforms and technologies for student engagement, improving video design, and pedagogical approaches that take full advantage of the affordances of videos. Focusing on video design, studies have sought to understand factors such as video length, style and content. Other studies focusing on affordances have sought to understand student usage patterns, student-video interactions and students' motivations for engagement. Within an engineering education context Dart, Pickering and Dawes (2020) found that students used problem-solving videos for clarifying understanding, replacing or catching up on missed tutorials, assignment and revision. They also found that students were overall positive towards the usefulness of the videos in their learning. In a further study Dart, Cunningham-Nelson, Dawes (2020) reported that students perceived audio explanations, content scaffolding and course alignment as the useful elements of videos. Dart et al. (Dart, 2020; Dart, Pickering and Dawes, 2020; Dart, Cunningham-Nelson and Dawes, 2020) found a linear relationship between video length and average viewing duration. That is that students engaged with longer videos for a longer period of time.

Video delivery styles within a single category, such as problem-solving videos have not been compared and there is conflicting research about student engagement between video classifications. Guo et al, (2014) found for content delivery in a MOOC that shorter videos, with a visible instructor were more engaging. Comparatively, Dart et al. (Dart, 2020; Dart, Pickering and Dawes, 2020; Dart, Cunningham-Nelson and Dawes, 2020) found longer videos using handwriting were more engaging. Therefore, research is still required to determine the best style (or styles) of video for problem solving videos to inform future content development and delivery.

Research Questions

This research project seeks to understand chemical engineering students' perceptions of problem solution videos generally at The University of Melbourne as well as their preference between three video styles communicating worked problems solutions. This research will enable other educators to make informed decisions regarding future development of worked problem solution videos.

This research project aims to answer the research questions:

- ***How do chemical engineering students at The University of Melbourne use problem solution videos?***
- ***Which video style (lecturer style, voiceover style, handwritten style) do students prefer as worked problem solution videos?***

Method

Context and Intervention

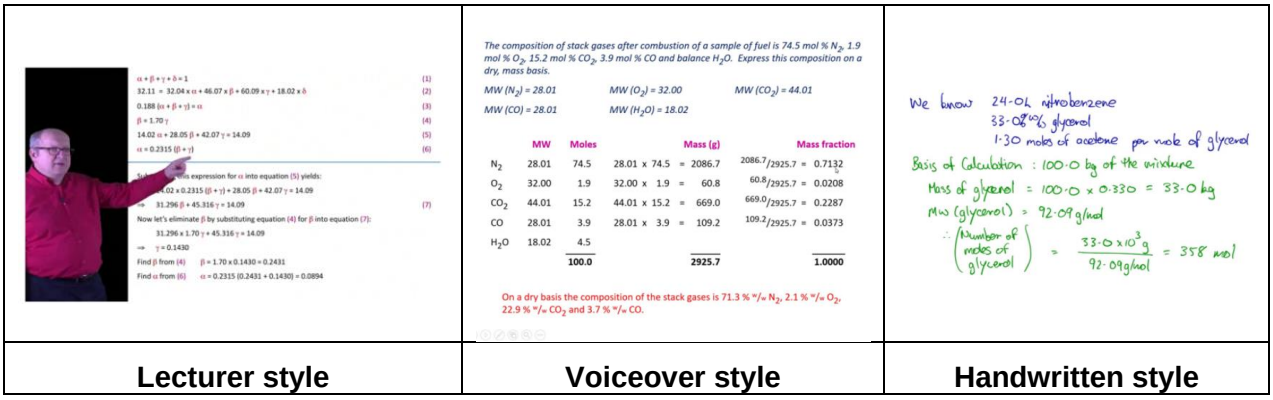
This study is situated in the context of Material and Energy Balances (CHEN20010) at The University of Melbourne, a second-year undergraduate subject that is core for those wishing to pursue further studies in Chemical Engineering at The University of Melbourne. It is primarily

taken by undergraduate students, although, some lateral entry Masters of Engineering students will take it. Within this subject, students' complete weekly problem sets of worked problems in tutorial workshops. The questions and final numerical answers are made available at the start of the week to students. At the end of the week, the full written solutions are released along with worked problem solution videos for most of the problems.

A total of 173 tutorial question solution videos were provided in one of three styles:

- **Lecturer style** – The presenter is visible in front of slides that detail the worked solution as they explain the solution.
- **Voiceover style** – The presenter is not visible as they explain the solution. The frame focuses on the slides that detail the worked solution.
- **Handwritten style** – The presenter is not visible as they explain the solution. The frame focuses on the solutions being digitally handwritten in parallel with the explanation using a stylus on a tablet. Commonly associated with the Khan Academy style.

Example frames from each video type can be seen in Figure 1. Each video is clearly labelled with the video style, E.g. "Video Solution to Sheet A Question 1 - Lecture Style", "Video Solution to Sheet A Question 2 - Handwritten Style", "Video Solution to Sheet A Question 7 - Voiceover Style". Early in the semester, only one video style is presented for any one problem. As the semester progresses, multiple style videos are presented for some problem solutions.



Lecturer style	Voiceover style	Handwritten style

Figure 1 Example frames of the different solution video types – Lecture style (left), Voiceover style (middle) and Handwritten style (right).

All videos cover the same type of content, going through a solution to an engineering problem. There is an approximate equal distribution of the different video styles throughout the subject and across different difficulties of problems being solved within the videos. Early in the semester there is only one style of video presented for each problem. Later in the semester there are two, and in some cases three styles of video for each problem.

All videos were developed by an experienced lecturer who has taught the subject for many years. Professor Shallcross is active in the engineering education research community and holds many teaching awards. The resources required to develop each type of video are included in Table 1, with lecturer style being the most intensive and voiceover style being the least intensive for both time and monetary considerations. In all cases professional quality microphones were used and in the case of the handwritten style, this microphone was used to record the sound rather than the in-built tablet microphone.

All videos were edited in Camtasia to improve the flow of the material by removing any excessive pauses or mispronunciations. The recordings were then rendered using the software package Handbrake in order to reduce the final file sizes.

Table 1: Resources required for the development of the three video styles.

Video style	Development resources
Lecturer style	PowerPoint slides, green screen, camera, professional quality microphone, display screen
Voiceover style	PowerPoint slides, professional quality microphone, Camtasia and Handbrake software
Handwritten style	Tablet or computer with writable screen, screen recording software, professional quality microphone, Camtasia and Handbrake software

Data Collection Method – A Survey

An online survey (using Qualtrics) was designed to investigate students' perceptions of the different worked problem solution video types. This survey included question themes as follows:

- Background information – gender, English as an additional language, enrolment
- Use of the problem solution videos – usage frequency, rewatching, watching more than one type, reasons for use, engagement with
- Usage enablers and intrinsic value of problem videos – file size, video duration, delivery style, further usage, improvement to learning
- Perceptions of different types of video styles – favourite, least favourite, ease of understanding, most often use, beneficial aspects, improvements

The questions included multiple choice questions (select the relevant category or multiple categories), 11-point Likert style questions (0-10 with a central point (5). Points labelled as agreeance statements as 'Not important (0) – Neutral (5) – Extremely important (10)', 'Not likely (0) – Neutral (5) – Extremely likely (10)' and 'Strongly disagree (0)– Neutral (5)– Strongly agree (10)') as well as qualitative open responses. It was anticipated this survey would take 15minutes to complete. No questions were mandatory.

Participant Recruitment

During a semester, the lecturer of Materials and Energy Balances would notify students that they will be invited to participate in a survey about their preferences around the worked problem solution videos after results for the subject are finalised in the final week of lectures. Accordingly, students were subsequently invited to participate in the survey via an announcement in the Learning Management System, Canvas, after results had been finalised.

Materials and Energy Balances runs once a year. Each cohort in 2021 and 2022 were invited to participate in this study as outlined above.

This data collection method and participant recruitment strategy was approved by The Office of Research Ethics and Integrity (OREI) at The University of Melbourne [Project ID Number 2023-22881-42409-4].

Data Analysis Method

Multiple-choice questions were aggregated and graphed.

Likert style questions were aggregated and reported as proportion agreed to some extent (selection of any point next to neutral through to positive pole; points 6-10) and disagreed to some extent (selection of point next to neutral through to negative pole; points 0-4).

Open response questions were analysed using inductive thematic analysis guided by Braun and Clarke (2013) in Excel. The question responses were assigned a term (or short phrase) the categorise their content (a code). All responses with a similar, or the same term assigned to them were then collated and themes were developed to fully characterise the response.

Results and Discussion

In total 29 students completed the survey. The respondent self-reported demographics are outlined in Table 2. These are included to categorise the student demographics of the sample population as a reflective sample of the broader cohort taking this subject. A standard cohort is around 70 students per semester. As the 29 responses encompasses 2 semester offerings, it represents around a 20% response rate.

Use of the Problem Solution Videos

Students were asked about their **use of the problem solution videos**. As shown in Figure 2, there was a broad range in the number of solution videos that respondents had used; a third of respondents had watched less than 10 videos of the 173-video set, while 10% had used between 50 and 100. When summed, 66% of respondents watched less than 30 videos, which is less than 20% of the total video set. As this data is self-reported and may contradict real watch statistics, further works investigating the view count and watch times from embedded learning analytics could be done to confirm these results.

Table 2: **Survey respondent self-reported demographics**

	Responses			
Enrolment type	‘Undergraduate’ 86%		‘Postgraduate (Master’s)’ 14%	
Gender	‘Male’ 52%	‘Female’ 48%	‘Prefer not to say’ 0%	‘Non-binary’ 0%
English language	English as a first language 45%		English as an additional language 55%	

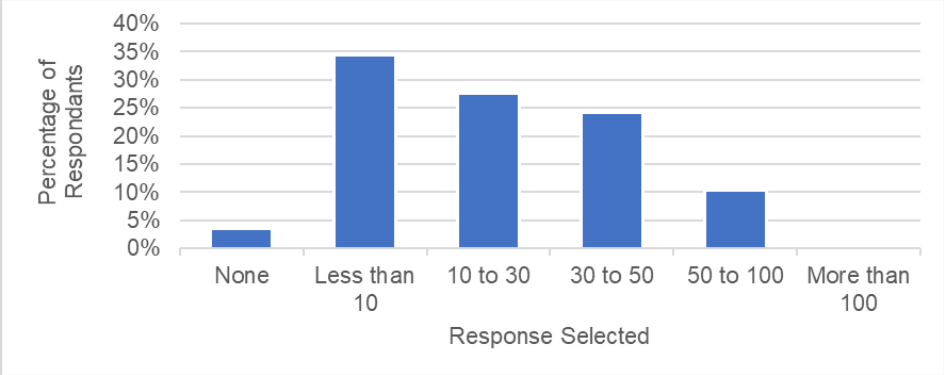


Figure 2 Responses when asked “How many solution videos did you use?”

As shown in Figure 3, when asked about **the frequency of viewing a video**, two-thirds of respondents had watched a video more than once on at least one occasion, and 52% had watched multiple videos answering the same question on at least one occasion. This reflects the responses when asked for **reasons for viewing videos**, Figure 4, where the most common response was to “Clarify understanding of content” and further responses indicate various forms of revision. Only one student who responded selected ‘other’ and responded qualitatively that the reason for using the solution videos was for helping with tutorial questions they were stuck on. This reflects a previous finding from Dart, Pickering and Dawes (2020) that found that students often used problem-solving videos for clarifying understanding and revision. Further works into viewing patterns are needed to gain insights into if there is a relationship between watching and the content. This may be useful in subject design to identify which content students are typically challenged by. While some may suggest this further investigation as a mechanism to identify topics to focus efforts for video development at the expense of others, we propose under a universal design for learning

model that alternative formats of delivering content are meaningful regardless of their correlation to high levels of use.

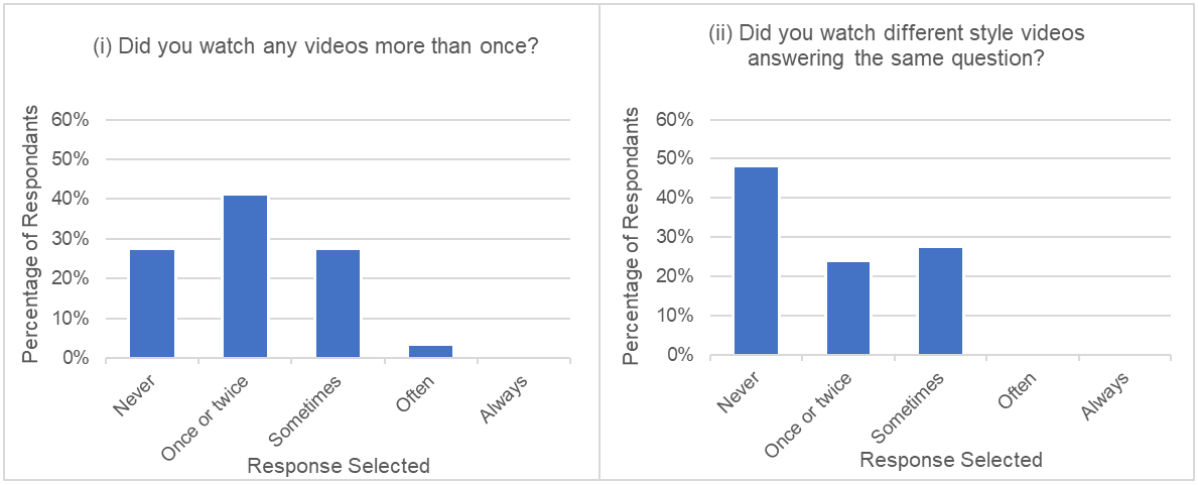


Figure 3 Responses when asked (i) "Did you watch any videos more than once?" and (ii) "Did you watch different style videos answering the same question?"

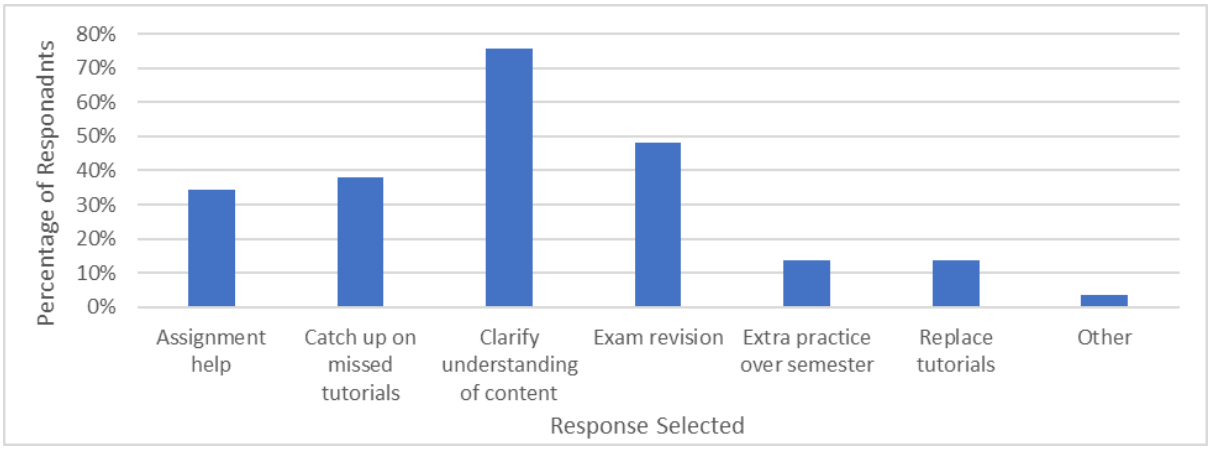


Figure 4 Responses when asked "For what reasons did you use the solution videos?" (Multiple selections allowed)

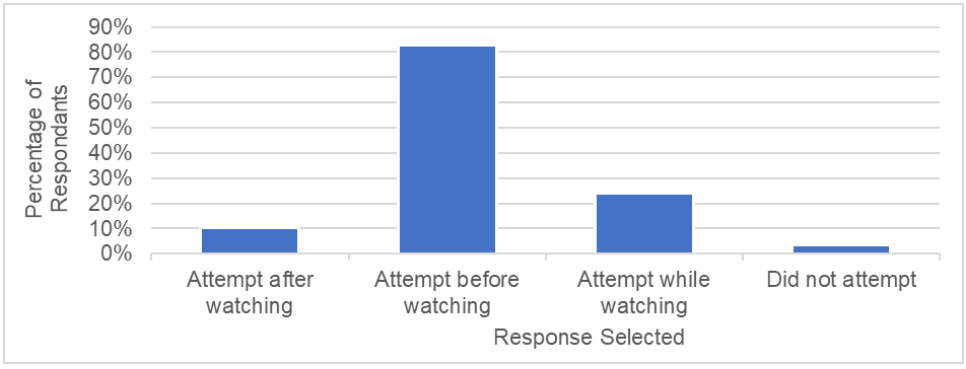


Figure 5 Responses when asked "How do you typically engage with the problems in the solution videos?" (Multiple selections allowed)

When asked how they **typically engage with the problems in the solution videos**, over 83% of respondents report that they attempt the problem before watching a solution video. This is positive, reflecting students using these as indicated in their reasons for use (clarification and revision) as well as following directives from the lecturer that they should ideally use the videos after attempting the problem. This is also reflective of students using videos to clarify challenging content and again,

further analysis may support identifying content areas students are finding typically challenging to inform further subject design choices.

Usage Enablers and Intrinsic Value of Problem Videos

The next section of questions probed **what was important to students when deciding which video to use**. 63% said the **style of video** was important (to some extent). Only 15% of respondents said that the **size of the file** was important (to some extent), and 30% said the **duration of the video** was important (to some extent). This finding on duration of video may reflect the contradictory findings in literature about watch times and video length (Guo et al, 2014; Dart, 2020; Dart, Pickering and Dawes, 2020; Dart, Cunningham-Nelson and Dawes, 2020). A further comparative study of students' watch times may be useful in understanding if the perception of these students reflects their actions.

96% of respondents said they would be likely to **use videos like these if they were available in other similar courses**, and no respondents said they would not be likely to use them. 96% of respondents agreed (to some extent) with the statement "My **understanding of the course improved after using the videos**". 89% of respondents agreed (to some extent) with that statement "I **think I will get a better grade in the course from using the videos**". This reflects the perceived usefulness of the videos to students. Even if this for a self-selecting sample, considering pedagogical concepts like learning styles or universal design for learning, it shows that there is usefulness is having solution videos as an option for students to engage with.

Perceptions of Different Types of Video Styles

Students were asked to compare the three styles of problem solution videos. It should be stressed that the results in this section are comparative results based on each respondent's personal preference. As discussed in method, mechanisms like presenter and an approximately equal spread throughout the semester were implemented to not unfairly influence this comparison.

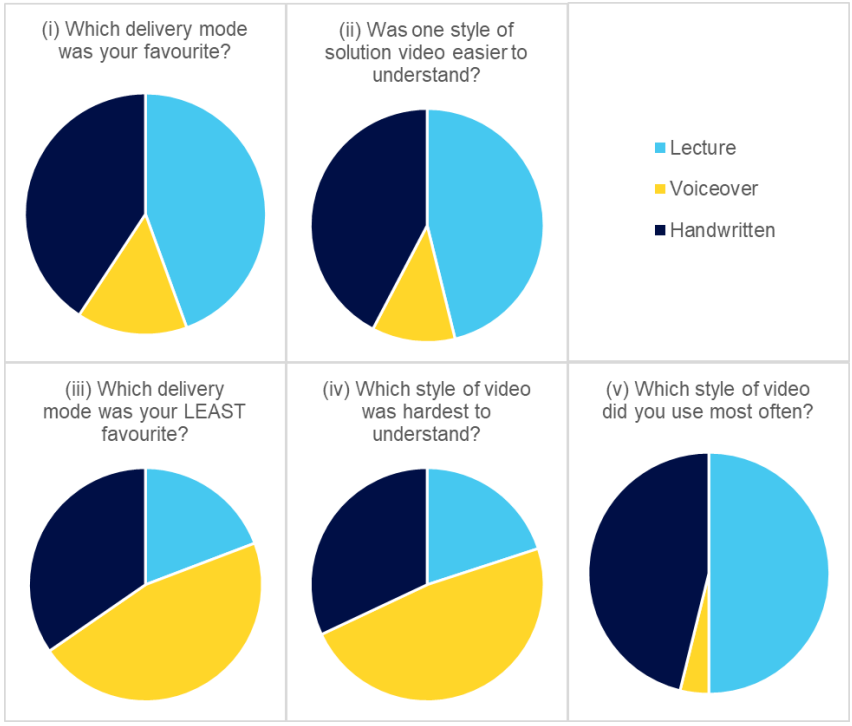


Figure 6 Respondents' perceptions of the different types of video styles

As shown in Figure 6, there were similar results to the questions "Which **delivery mode was your favourite?**" and "Was one **style of solution video easier to understand?**". In both cases the

Lecture and Handwritten styles were popular, each receiving between 40 and 50% of the responses. Further, the inverse questions reflected these results with responses to the questions "Which delivery mode was your **LEAST favourite**?" and "Which style of video was **hardest to understand**?" most commonly reporting the Voiceover style (46% and 48% respectively). Of note was that Lecture style had only 19 % and 20% respectively, while the Handwritten was 35% and 32% respectively to these questions. Finally, 50% of respondents said **they used** the Lecture style of video **most often** and 46% said Handwritten. Putting these results together and holding them in balance, it is clear the least preferred video style is voice over. However, it is unclear between the Lecture style or Handwriting style which is the preferred mode. These results may suggest that between the two it is a student dependent preference.

When prompted to respond about **what it was about their preferred style that they found useful**, respondents noted features about the delivery quality, application, and their own preference regardless of their preferred video style. Considering the delivery quality theme, handwritten preferences responded that the speed and pacing of the videos were favourable as each step was revealed one at a time at a pace similar to their own in working through the problem. Conversely, those with a preference for lecture delivery style appreciated that all solutions were displayed in a single step. This perhaps reflects different learning styles and preferences for content consumption to support the learning process. No students who selected a preference of voiceover responded to this question.

When asked **what aspects of the videos were most beneficial**, respondents who preferred each video type made note of step-by-step nature of the videos and detailed explanations. The neat writing and discussion of different methods were highlighted by respondents who preferred the handwritten video style. Similarly, the quality of the recording and delivery style (clarity and pace) were noted by respondents who preferred the lecture video style. Additionally, those that preferred the lecture video style also noted the individualised tutorial feel of the videos that made them beneficial as well as the flexibility to review on demand.

When asked **how the videos could be improved,** respondents who preferred handwritten videos most noted that the videos could be shorter in length. Those who preferred lecturer video types noted that the greenscreen of the lecturer could be edited to ensure that it does not block the slides. One respondent also noted at this point that it would be good if the videos could be available in more subjects.

Conclusion

The 29 students from Material and Energy Balances (CHEN20010) at The University of Melbourne that completed the survey reported most commonly using problem solution videos for clarifying understanding and revision related activities in line with previous studies findings. They reported commonly watching a video more than once, attempting questions before watching the videos and only watching specific videos (<20% of the complete set) reflecting the reported use case. Students reported largely watching the same video style and that the style of video was important to them. Students also reported they thought the file size and duration of video were not important, although, some responded that the videos could be improved by a shorter duration. Overall, students found the solution videos useful, reporting that they think it improved their understanding and grade as well as reporting that they would be likely to use them in other subjects. This characterisation answers the first research question, *how do students use problem solution videos?* Further works may work to investigate if there is a relationship between the videos watched and the problem solved in the video to gain insights into if there is a specific problem type that could be targeted with future subject development focus. Similarly, students' viewing data could be analysed to see if it reflects the self-reported results.

While it was clear that the voice over style was students' least favourite style, there is not a clear answer to the second research question, *which video style do students prefer?* This is as it was unclear between lecture and handwritten which students preferred and found easiest to understand. This was furthered by what students noted as elements they preferred and found beneficial of each type being largely related to the same themes. These included the pacing or speed of the videos and the explanation being stepwise in nature, although for those who preferred the handwritten video style this was as the solution was revealed one line at a time while those that preferred the lecture video style it was as they could see the solution all at once. Only minor editorial suggestions were made to each for improvements. This perhaps suggests there is some usefulness in having multiple styles of videos available for students' consideration based on their individual preferences. However, given the significance differences in time, money and resources to produce these two styles, it may suggest that the best 'value' investment for those starting out on making problem solving videos may be using the handwritten video style. Further works may consider viewing data of students to understand if it reflects their self-reported reality.

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