ŌTAUTAHI CHRISTCHURCH AOTEAROA NEW ZEALAND
35TH AUSTRALASIAN ASSOCIATION FOR ENGINEERING EDUCATION ANNUAL CONFERENCE
8-11 DEC 2024
THE ENGINEER AND THE WORLD

Pre-recorded Practical Preparation Videos Used as a Tool to Enhance Student-Centred Learning and Support Cost Effective Delivery

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ABSTRACT

CONTEXT

With the intention to encourage more student-centred learning (alongside reducing the duration of the practicals) we used pre-recorded practical preparation videos in a second-year course 'Electrical Circuits and Applications' at an Australian University. The presented practical engineering concepts and applications were delivered across electrical, electronic and robotics engineering student cohorts. The emphasis is to ensure individual autonomous learning of each participating practical class student (prior to entering the practical learning session) in the form of a student self-directed guide.

PURPOSE OR GOAL

The aim of this study was to determine whether the students would better engage in their practical learning (if provided with on demand visual and auditory guidance before the class.) If that was the case, we would then encourage other academics to use this (or similar methods) across practical sessions in the first and second years of engineering study. The introduction section of the work explores techniques/reasonings behind efficient video production. The leading assumption of our investigation was to examine the impact of applied video recordings as a transitional method in achieving an efficient and self-centred student learning experience.

APPROACH OR METHODOLOGY/METHODS

Our brief quantitative/qualitative study involved simple data collection (using the Qualtrics online survey.) It required students to complete a questionnaire on their perceived experience of the learning process. Questions were used to determine the satisfaction of the students' educational experiences to detect the possible course-related educational and operational benefits. Constructs in the questionnaire were operationalised (using multi-item, 11- point Likert scales) which were only used as an investigation instrument (with a common frame of reference from 0-10.) Additional qualitative data was collected on the participants' views of how "Pre-recorded Practical Preparation Videos" could benefit their own and future students' learning.

ACTUAL OR ANTICIPATED OUTCOMES

That approach created a higher level of interaction between the academic staff and students (during practical sessions) by saving time on unnecessary instructions and explanations. It allowed students to question the presented practical content and simultaneously explore potential real-life applications of the newly gained knowledge.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The provided pre-recorded practical preparation videos did more than just a provision of guidance to the students. It allowed the students to better engage in their self-centred learning, by shortening classes (which meant more cost-effective delivery with adaptable scalability).

KEYWORDS

Cost Effective Delivery, Pre-recorded Practical Preparation Videos, Student Centered Learning.

Introduction

Video is a flexible and effective learning tool used in modern teaching that provides accessibility at any place and time. According to (Gedera & Larke, 2019; Hsin & Cigas, 2013) when used correctly it enhances student learning and experience. Videos must be carefully planned and designed to stipulate deep, meaningful and active learning - by using the most efficient pedagogical elements and techniques known as “interactive learning moments” (Gedera & Zalipour, 2018). The Bureau of Internet Accessibility, Inc. (2020) recommended that videos could be used as an additional aid for students with disabilities (by provision of captioning and transcripts) as alternatives to audio. Such practice is used to ensure accessibility to all students in the cohort/s equally.

During the process of video making, we used the following techniques: segmentation, personalization, congruity, signalling and coherence. According to (Kim et al., 2014) segmentation is a technique used in video production, where each video is short in duration (6 minutes or less) and covers specific concepts or topics. Gedera & Larke (2019) recognized that students need to see their teacher in the video, so that they can feel better connected to the presented content. Such personalization is especially important when the teacher provides expertise by adding specifically targeted instructions or explanations.

Reflecting upon Mayer (2009) the sole purpose of video-based learning is to maximise learning by presenting information simultaneously (both auditory and visually) which increases processing in the brain working memory and prevents cognitive overload. However, this only works if there is congruity between the auditory and visual information. Mayer (2009) also pointed out that signalling or cueing should be used to highlight critical and important video information (through the use of keywords and symbols on the screen.) The major aim that we tried to achieve in our videos was the balanced visual flow. According to (Guo et al., 2014) this flow is important in video production, as it is based on the coherence principle in creating multimedia in order to avoid cognitive overload.

It was discovered that watching the video materials alone was not sufficient to secure an effective learning process. Video materials need to be purposefully integrated with other activities and observations in order to keep students engaged in active learning process. This could be achieved by provision of brief outline at the beginning of the video, encouragement of note taking in the process of video observation, incorporation of critical questions at the start of the video to stipulate link between practical task/s and theoretical concepts (using video analytics).

Although numerous studies (such as Vial et al. (2016)) were previously covering similar provision of online video resources (used as pre-preparation before entering practical sessions) the uniqueness of our approach was that we had developed our practicals and all other supporting materials. This includes pre-preparation practical videos produced in house (by cooperation between the Topic Coordinator/Lecturer, Teaching Staff involved in running the second-year course “Electrical Circuits and Applications” and the Technical Service Department) by following above presented recommendations and techniques.

Please note that the presented references were related to the process of ‘how to produce video materials’ in order to serve the purpose of students’ self-centred learning most effectively. Most often, journal articles do not cover recommendations regarding practical implementations and suggestions related to video production. This is most commonly treated as assumed knowledge.

Background and Motivation

This study outlines the effective use of the pre-recorded practical preparation videos that cover theoretical and practical aspects of specifically designed six practicals (related to the course “Electrical Circuits and Applications”) across electrical, electronic and robotic student cohorts (enrolled in the second semester of the second year of an undergraduate and the second semester of the first year of postgraduate degrees) at an Australian University. Following the

recommendations presented in (Gedera & Zalipour, 2021) most of the produced videos (95%) were short, targeted and personalized.

Our intention of introducing the pre-recorded practical preparation video materials was to encourage a more student-focused learning of the applied theoretical and experimental concepts (alongside procedures) with the aim to enhance and support individual autonomous learning.

The most recently developed expertise (in the use of videos to support lectures) has been adapted to the practical-based learning, by producing video materials as self-directed guides. The leading assumption of our investigation was to examine the impact of applied video recordings

(with the aim to provide more efficient practical pre-preparation) to improve both students (alongside staff) experience, by creating more time for higher level interaction. Table 1 below presents a summary of each practical content (including the link to specific course content/outcome) related to the second-year course "Electrical Circuits and Applications".

Table 1: Summary of each practical Set of Short Videos including Video Content relation to Specific Course Content/Outcome related to the second-year course "Electrical Circuits and Applications"

Practical:	Set of Short Videos covering:	Video Content relation to Specific Course Content/Outcome:
1	RC and CR circuits at 50Hz & 5 MHz AC frequencies	Phase Shifting, Input and Output Voltage Amplitude Analysis, Low and High Pass Filtering
2	RL and RC Circuit Voltage and Current Analysis	Voltages and current phasor relationships applied to simple RL & RC circuits at 50 Hz
3	RL and RC Circuit Power Analysis	Active, reactive and apparent power analysis applied to simple RL & RC circuits at 50 Hz, Link between impedance triangle and power triangle
4	Self and Mutual Inductance Measurements & B-H Curve of the Simple Reactor	Self and Mutual Inductance Measurements of two coils connected in series (in the air and in presents of iron core), Total iron losses of the simple reactor
5	Single Phase Transformer Tests (Open-circuit, Short-circuit and Load Tests)	Determination of the equivalent circuit parameters of the single-phase transformer, as well the copper/ iron losses measurements used for determination of transformer regulation and efficiency
6	Stepper Motor (Single Stepping, Holding/Dented Torque, Maximum Rate, Stepping Torque, Trapezoidal Control)	Exploration of Stepper Motor Performance Characteristics to learn how to choose the most appropriate stepper-motor in practice

Method

Table 1 below presents a summary of our video materials (used for pre-practical preparations) including information about type, duration and number of produced individual videos per each practical. As it can be seen from Table 2, out of 87 videos, 82 were of short duration (from 0.5 minute up to 5.85 minutes) while out of 5 medium length videos 4 were between 7.13 minutes up to 8.6 minutes. Only one video lasted 12.62 minutes.

Table 2: Summary of Short versus Medium Length Videos including Total Watching Time per each Practical Preparation

Practical:	No. of Short Videos:	Duration Frame of Short Videos [minutes]:	No. of Medium Videos:	Duration Frame of Medium Videos [minutes]:	No. of Practical Demo Videos:	No. of Theoretical Explanation Videos:	Total Time of All Videos [minutes]:
1	12	0.58 – 5.45	2	7.77 – 8.6	9	5	43.25
2	13	1.47 – 5.1	1	7.93	13	1	47.39
3	12	1.93 – 3.5	0	N/A	12	0	31.19
4	18	0.5 – 2.57	0	N/A	16	2	23.52
5	13	0.83 – 5.85	1	12.62	8	6	49.34
6	14	0.83- 5.58	1	7.13	15	0	47.36

This short quantitative/qualitative study involved a simple data collection (using the Qualtrics online survey tool.) It required students to complete a questionnaire on their perceived experience. The survey was conducted across the electrical, electronic and robotics undergraduate (alongside postgraduate) student cohort enrolled in the topics. The survey was distributed and scheduled in week 12 of Semester 2, 2021 to 2023 – as a diagnostic tool. Questions used in the questionnaire were created to track the satisfaction of students' educational experiences to detect the possible topic-related educational and operational benefits.

Constructs in the questionnaire were operationalized (using multi-item, 11- point Likert scales) which are not only used as an investigation instrument, but also as an assessment tool (with a common frame of reference from 0-10) which could be easily interpreted. A single item measure was used so that the informal distinctions can be made among respondents. Participants rated the level describing their perception, which was straightforward and easy to administer.

Furthermore, those scales were also suitable as the questionnaire served as a tool that best describes their ability to use "Pre-recorded Practical Preparation Videos." Only the qualitative measure item was a question related to the participants' views on how "Pre-recorded Practical Preparation" video material benefited their personal/professional learning and development. A demographic data was provided first, followed by the questionnaire (presented in Table 2) and finally the associated results/findings and pedagogical implications of the study were addressed.

Demographics

Of the 179 students enrolled across two topics from July 2021 till November 2023, 167 were male, while only 12 were female. Of these 179 (100%) students, 63 (35%) chose to fill the survey of which 55 (87%) males and 8 (13%) females. The age of students who decided to participate ranged from 19-21 years (30), 22- 25 years (16) and 26+ years (17).

Questionnaire

Instructions: Please highlight your answer on a scale of 0-10 (0=strongly disagree and 10=strongly agree, 5=neither agree nor disagree) concerning your opinion about the presented statement(s).

Table 3: Questionnaire Measures and Scaling

Measurement item	Scale
Using pre-recorded practicum preparation videos helped me to better prepare for practical work	0 1 2 3 4 5 6 7 8 9 10
Using pre-recorded practicum preparation videos helped me to learn how to use lab equipment	0 1 2 3 4 5 6 7 8 9 10
Using pre-recorded practicum preparation videos helped me to establish link between theory and practical applications based on experimental findings	0 1 2 3 4 5 6 7 8 9 10
Using pre-recorded practicum preparation videos helped me to better understand practical limitations of measured results compared to analytically obtained predictions	0 1 2 3 4 5 6 7 8 9 10
Please provide in your own words, why you think that this kind of pre-recorded materials could benefit your personal/professional learning and development.	Qualitative Data Collection
Would you like the same method of Online Lecture delivery to be implemented in other topics in your course	1. Yes, I would like that other topics use it. 2. No, I did not find it beneficial. 3. I have no preference.

Results

The provided pre-preparation videos did more than just a provision of guidance through the practicals. The average time that was calculated (using data collected in Table 1) for each student to watch per-practical preparation videos was 40.35 minutes per practical session. This shortened the total class time from 58.5 to 40.5 (laboratory hours per course) producing an overall decrease of practical duration by 31% (or 18 hours.) Such decrease in practical durations has produced significant reduction in casual teaching budget needed for the running of the practical part of the topic.

It is worth mentioning that in-door production of such video recordings is not always possible, due to time, staff and resource constraints. Very often in practice, organizations try to use externally produced resources as a replacement for something, which is far more authentically in-house created and better matched with actual practical resources used during practical sessions.

As presented in Table 4 below, collected data revealed that most respondents found the videos to be a more helpful preparation tool than standard in class demonstration (especially when it comes to learning how to use laboratory equipment.) Therefore, linking theory with practice includes taking into consideration of the practical limitations of measured results compared to analytically obtained predictions (standard average score was varied between 7.79 and 8.70 out of 10 scale while standard deviations were between 1.71 and 2.27).

Table 4: Summarised results of the student questionnaire

Measurement Item (from 0 to 10)	**Avg**	**Min**	**Max**	**SD**
Using pre-recorded practicum preparation videos helped me to better prepare for practical work	8.56	1	10	2.07
Using pre-recorded practicum preparation videos helped me to learn how to use lab equipment	8.70	2	10	1.71
Using pre-recorded practicum preparation videos helped me to establish link between theory and practical applications based on experimental findings	7.97	1	10	2.27
Using pre-recorded practicum preparation videos helped me to better understand practical limitations of measured results compared to analytically obtained predictions	7.79	2	10	2.17

Please note that (for the first three practicals) students were also asked to perform calculated pre-preparation mathematical predictions by provision of the circuit /test parameters at specific given frequency. It is worth mentioning that the possibility of such activities may also conflate the effects of mathematical predictions (with the use of videos) to give somewhat misleading reporting of improved experience due to the videos. The proper feedback on the correct mathematical prediction answers were provided to students straight before entering the practical sessions to allowed them space and time to compare obtained measurements with expected circuit behaviour. However, the other three practicals did not use such predictions. Overall, the result could still be valid.

Although Table 4 showed minimal scoring of 1-2, a closer look into the data confirmed that only one student allocated such a low scoring, due to the fact that he was not seriously engaging with the topic content. He did not put any effort to properly prepare for the upcoming practical sessions.

Additionally, qualitative data responses have confirmed that the learning process (started by watching the videos) followed (in three out of six sessions - by mathematical preparatory predictions before entering the practical session with an exposure to the experimental measurements) was finalized by the performance of the result analysis. Students also identified that (by accessing pre-recorded preparation materials) they were able to achieve more individual and autonomous learning. They also had more time ensured for proper and in-depth analysis of obtained versus pre-calculated results. They noted a more efficient use of the demonstrator's time, by engaging them in a higher-level of interaction.

One of our surveyed students stated*: 'The pre-recorded practicals allow for a quicker start to the practical while also allowing the freedom to go back to a video if stuck quickly. I also feel that it gives the demonstrators of the lab more time to help with more difficult issues then setting up the practical. The videos also allow for a greater understanding as to what can be expected of the lab allowing for clearer direction.'*

Figure1 below presents the outcome of the final survey question 'Would you like the same method of Pre-preparation Practical Video to be implemented in other topics in your course?' It can be concluded that most of the participants – 56 (88.8%) would like that other topics adopt this pre-preparation practical delivery, while 6 (9.5%) have no preference and only 1 (1.7%) of all students did not find it attractive. This student who did not find it beneficial, was a mature aged student.

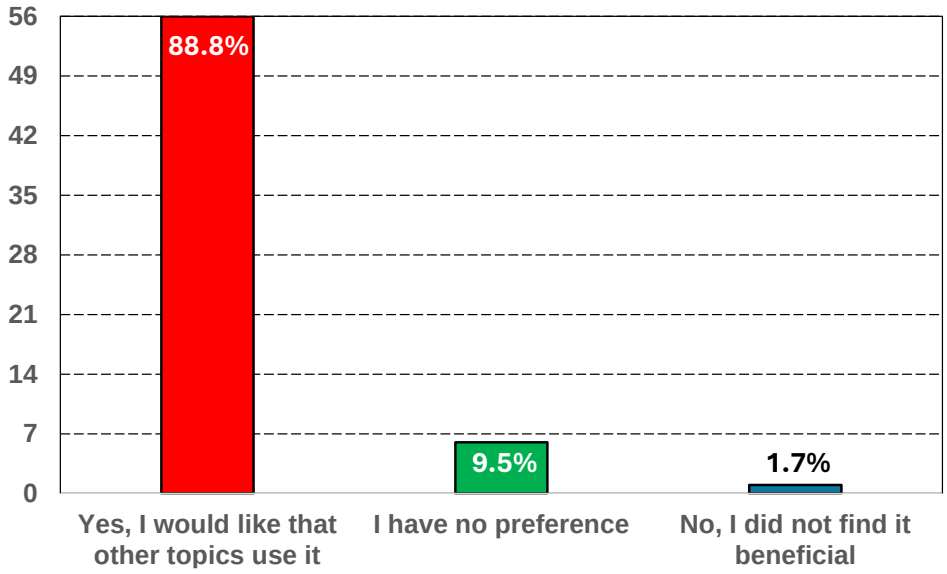

Figure 1: Answers on survey question 'Would you like the same method of Pre-preparation Practical Video delivery to be implemented in other topics in your course?'

Please note that specific demographic data showed relatively low percentage of female students enrolled in overall cohort across time-period of three consecutive years (only 6.7%). For such reason, any sustainable gender analysis of data has not been performed.

Findings/Benefits

The proposed research is significant, as it contributes equally to the research literature in: (a) education and (b) innovation in teaching. Additionally, qualitative/quantitative data responses have confirmed that the learning process resulted in an overall increase in students student-centred learning experience.

It becomes apparent that the re-usable learning materials are of great importance for more enquiry-based and timely learning. The implication of using video recordings in this study (alongside experimentally obtained measurements) allow for cost effective delivery (producing an overall decrease of practical duration by 31%) with possible adaptation related to remotely guided practicals. Although other engineering academics have tried to produce the practical videos in the past, none of them have performed any analysis of their actual educational value and cost efficiency to justify the quality of the presented educational material for future re-use.

The largest benefit of such approach was recorded among students from non-English speaking backgrounds enrolled in postgraduate master courses and programs (probably due to language barriers and online availabilities of the presented content - alongside their working commitments outside of the university.) We believe that our approach (using pre-recorded practical preparation delivery) could be extremely beneficial for any institution that would like to cut the cost of their casual teaching budgets.

It is worth mentioning that the pre-recorded practical preparation videos are scalable and equally applicable on the small, medium and extra-large student bodies. As such, this could be an extremely useful self-centred teaching tool.

Future Work

It would be interesting to investigate how the obtained results defer from future findings once they will be implemented across the first and second year of other electrical, electronic and robotic courses (under the assumption that all casual teaching staff is properly trained before supporting students in their practical sessions.)

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