Impact of Lecture Recording in Undergraduate Engineering Classes: Students' Perception and Academic Attainment

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CONTEXT
In many higher education institutions, it has become routine to digitally capture traditional classroom lectures and automatically make those recordings available to enrolled students after the classes to view at any time and in any place. Whilst the use of lecture recording (it is also referred to as lecture capture) has been studied extensively, much is still unknown, particularly in the Engineering discipline, about students' perception and use of lecture recording and its impact on their academic attainment in different classroom sizes. Additionally, there is an emerging concern by the educators on how the lack of students' in-class attendance, as a result of lecture recording, may affect their active and experiential learning experience. As a consequence, students who do not attend lectures would fully or partially miss out on the activities (such as in-classroom experiments, model displays, group discussions, etc.) which are designed to improve their learning experience.

PURPOSE OR GOAL
The goal of this study was to understand the correlation between Engineering students' perception and use of lecture recording, and their academic performance in different classroom sizes with the view of improving lecture recording features and students' success. In particular, the correlation between academic performance, attendance (in-person engagement) and remote engagement (using lecture recording) was investigated in small and large undergraduate Engineering Knowledge and skill based (analytical-based) courses, involving in-class active and/or experimental activities, where students had access to recorded lectures.

APPROACH OR METHODOLOGY/METHODS
This study was conducted across two Australian universities, Griffith University (Nathan campus) with small classroom size, Griffith University (Gold Coast campus) with large classroom size and Queensland University of technology with large classroom size. The focus was on undergraduate Engineering Knowledge and skill based (analytical-based) courses, involving use of active and/or experiential learning approaches, being taught as a part of Civil Engineering programs. All classrooms were equipped with lecture-capture technology using the Echo360 system and links to the lectures were made available immediately after each class. Students in-class attendance was taken by the instructors. Towards the end of the course, instructors announced in class and posted in their course website, a link to an online questionnaire to investigate students' perception and use of the lecture recordings. This data was then compared with analytic data available in Echo360 and students' overall course marks.

ACTUAL OR ANTICIPATED OUTCOMES
The paper reports the results of an investigation that was conducted to find the correlation between Engineering students' perception and use of lecture recording, and their academic success. It presents the effects of different classroom sizes. Additionally, it presents some of the potential shortcomings of the lecture recording and suggest some appropriate strategies to improve the lecture recordings towards excelling students' success.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY
The paper presents the outcomes of the study that was undertaken to gain insight on the undergraduate students' perception and use of lecture recording and its impact on their academic success with the view of identifying the improvements that need to be made on digitally capturing traditional classroom lectures.

KEYWORDS
Lecture recording, Students engagement, students' perception, classroom size

Introduction

Increasingly ubiquitous nature of technology both inside and outside of the classroom is changing how our students access information, take notes, study, and interact with their instructors and peers. One of the exciting technologies that has drawn the attention of instructors and students over the last decade on university campuses across the world is the lecture recording (it is also referred to as lecture recording). Zhu and Bergom (2010) describe lecture recording as an "umbrella term describing any technology that allows instructors to record what happens in their classrooms and make it available digitally". The last decade has witnessed growth in the use of lecture recording in a wide range of disciplines within higher education (Walker, Voce, Ahmed, & January, 2012). All 43 universities in Australia are now the members of Australasian Council on Open, Distance and e-Learning (ACODE) and are using a type of lecture recording systems (*e.g.* Echo360, Camtasia Relay, Media Site).

Such introduction of lecture recording has been widely welcomed by student who appreciate the flexibility that it brings, allowing them to view lecture material multiple times at any time, in any place and at their own pace. Empirical evidence suggests that combining lecture recording with face-to-face instruction increases students' satisfaction and enjoyment of courses (Alexander, Barcellona, McLachlan & Sackleya, 2019; Secker, Bond, & Grussendorf, 2010; Greenberg, Nilssen, & Adoption, 2009; Bryans Bongey, Cizadlo, & Kalnbach, 2006). Additionally, lecture recording assist students' understanding of confusing or complex information and helps clarify issues by enabling students to navigate the lecture recording for later studying and reviewing of the lecture materials (Savoy, Proctor, Salvendy, & Education, 2009; Chiu, Lee, & Education, 2009; Bryans Bongey et al., 2006).

Despite these advantages of lecture recording, concerns have been raised globally by educators and faculties on the effects of lecture recording on students' in-person attendance and academic performance. A large body of literature to date has focused on investigating the effects of the lecture recording availability on students' attendance. The outcome of these studies have clearly shown that the availability of lecture recording has a negative correlation with student lecture attendance (Edwards & Clinton, 2019; Golding, 2011; Kucsera, Kishi, & Traphagan, 2010; Newman-Ford, Fitzgibbon, Lloyd, & Thomas, 2008; Harley et al., 2003). Additionally, a number of studies have been conducted to investigate the effects of lecture recording on student's attainment. However, these studies have mainly focused on non-engineering courses and their results are mixed.

Some studies suggest that lecture recording assists students to achieve better test scores (Griffin, Mitchell, Thompson, & Education, 2009; McKinney, Dyck, Luber, & education, 2009; Grabe & Christopherson, 2008; Day & Foley, 2006). Day and Foley (2006) conducted a research to examine the use of web lectures to enhance the classroom learning experience in an introductory Human-Computer Interaction (HCI) course. Their findings showed that students learning HCI using their web lectures earned significantly higher grades than students in a traditional lecture-based class. This is due to the fact that by using web lectures to present lecture material before class, more in-class time can be spent engaging students with hands-on learning activities. Grabe and Christopherson (2008) examined the relationships between the use of online lecture resources and examination performance of a group of voluntary students. The participants were enrolled in two Introductory Psychology courses at a moderate sized university. This study demonstrated a positive relationship between online note usage and examination performance. Griffin et al. (2009) carried out an experimental study at the University of Kent at Canterbury during the spring Trimester of the 2007–2008 academic year. The participants were full-time students studying at the University. Majority of participants were from the Social Sciences and Humanities faculties while minority of participants were from Science faculty (58-33-9 ratio). The results of their study suggested that an introduction of e-learning as a blended learning approach was equal in standing, if not better, to a traditional approach. McKinney et al. (2009) performed a study to determine the effectiveness of audio lectures in higher education. The participants were psychology students

attending a small, liberal arts college in New York state. The results of their study indicated that students in the podcast condition who took notes while listening to the podcast scored significantly higher than those in lecture condition.

On the other hand, some studies showed no significant impact stemming from the use of lecture recording on students' grades and examination performance (Bassili & Hypermedia, 2008; Harpp et al., 2004). Harpp et al. (2004) studied the correlation between lecture retrieval from the website and student's grade. The participants were students from the Department of Chemistry as well as Department of Computer Science at McGill University. Their study outcome showed that the students' grades were not affected in any dramatic fashion by the retrieval lecture system. Bassili and Hypermedia (2008) also investigated the impact of lecture recording on students' grades. The participants were students who enrolled in a large psychology course at the University of Toronto Scarborough. Their findings indicated that there was no difference in learning outcomes linked to media (*i.e.*, lecture recording).

Additionally, the findings of an investigation by Edwards and Clinton (2019) highlighted a negative impact of lecture recording introduction on student attainment, which is mediated by the reduction in attendance at lectures.

Given such limited and mixed data available in the current body of literature on the impact of lecture recording on students' attainments, particularly in Engineering courses, a research has been initiated at Griffith University (GU) in collaboration with Queensland University of Technology (QUT) to bridge the knowledge gap.

Aim and Objectives

The goal of this study was to understand the correlation between Engineering students' perception and use of lecture recording, and their academic performance in different classroom sizes with the view of improving lecture recording features and students' success. In particular, the correlation between academic performance, attendance and remote engagement (using lecture recording) was investigated in small and large undergraduate analytical-based courses, involving in-class active and/or experimental activities.

Approach

This study was conducted across two Australian universities, Griffith University (Nathan and Gold Coast campuses) and Queensland University of technology. The focus was on undergraduate Engineering knowledge and skill based (analytical-based) courses, involving the use of active/experiential learning approaches that are being taught as integral parts of Civil Engineering programs. The selected courses were Mechanics of Materials I (2101ENG), Structural Analysis (3101ENG, manual and computer-based structural analysis) and Finite Element Method (EGB485, computer-based structural analysis). Whilst the first two courses are offered at Griffith University, the third course is offered at Queensland University of technology. A brief summary of these analytical-based courses is contained in Table 1:

To carry out the proposed study, the class size of less than 50 was deemed as small and the class size of equal to or more than 50 was considered large. It is believed that such a definition of class sizes is common in Engineering courses in Australian universities. Based on this definition, Griffith University's Nathan campus classes (2101ENG and 3101ENG) were considered small, whereas, Griffith University's Gold Coast campus classes (2101ENG and 3101ENG) as well as Queensland University of Technology's class (EGB485) were considered large.

All classrooms across the selected universities and campuses were equipped with lecture-recording technology using the Echo360 system. This lecture recording system was able to record instructor's voice, PowerPoint slides, document cameras, videos, and web surfing and the link to the lectures were made available immediately after each lecture. However, the recoding system examined in this study, which is commonly used in Australia, was not able to

record the in-classroom experiments/demonstrations or allow online students to be involved in the live group discussion or activities.

During the teaching Trimester, students in-class attendance was taken by the instructors. Towards the end of the course, instructors announced in class and posted in their course website, a link to an online survey to investigate students' perception in using lecture captures. This data was then compared with analytic data on students' remote engagement available in Echo360, the students' in-person engagement/in-class attendance obtained by the instructors during the teaching Trimester and their overall course marks. The online engagement score was based on the number of times students viewed/watched the recorded videos.

Table 1: A brief summary of the selected analytical-based courses

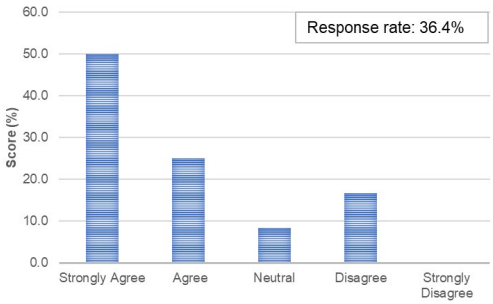
Course Name (Course ID)	Course type	Year Offred	Course Description	School/University Name	Enrolment Number (Trimester 1, 2019)
Mechanics of Materials I (2101ENG)	Analytical-based (core course)	Second year	This course develops students' understanding of, and ability to apply, both theoretical and experimental stress analysis techniques to real world engineering design tasks.	School of Engineering and Built Environment/Griffith University	Nathan campus:33 Gold Coast campus:142
Structural Analysis (3101ENG)	Analytical-based (core course)	Third year	This course develops the ability of the students to analyse planar structures using manual and computer-based methods.	School of Engineering and Built Environment/Griffith University	Nathan campus:17 Gold Coast campus:129
Finite Element Method (EGB485)	Analytical-based (core course for structural engineering major students and elective for others)	Final year	This course develops advanced knowledge and methodology in computer-based structural analysis. These will enable the analysis of complex structures under both static and dynamic loads.	School of Civil Engineering and Built Environment/ Queensland University of Technology	Gardens Point campus: 57

Outcomes and Discussion

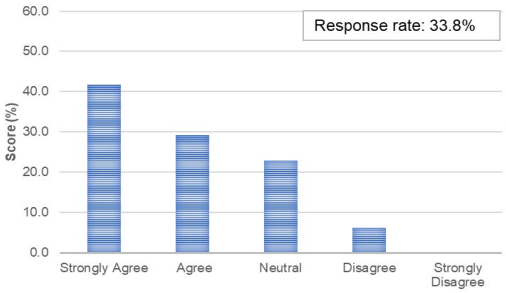
Students' perception of the lecture capture impact on their performance

In the online survey, which was carried out at the end of the Trimester, the instructors specifically asked students if they thought the recorded lectures assisted their learning and hence their performance. Figure 1 shows the typical response of students to this question. It can be seen from this figure that more than 70% of participated students either agree or strongly agree that using the recorded lecture would assist their learning and their performance.

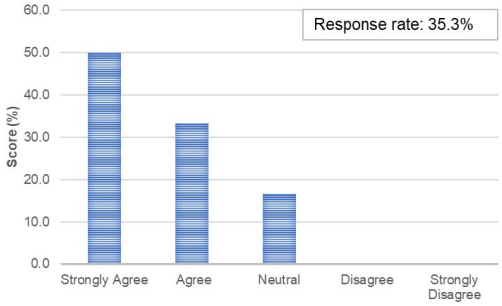
In addition to this question, a qualitative response section was allocated in the survey for students to provide detailed feedback. The main feedback was from the students, who could not attend the lecture in person due to various reasons including full-time jobs, caring of young children or ill parents. Their request was to find a way to record the in-class physical demonstrations. It is believed that these students (less than 30% of participated students) are those who selected "neutral" or "disagree" in the online survey. Additionally, it can be seen from the figure that some students selected "disagree" in Mechanics of Materials I course (at both campuses) but not in Structural Analysis course. This could be due to the fact that Mechanics of Materials I course involved more physical demonstrations, which could not be captured, compared to the Structural Analysis course."



(a) 2101ENG (GU-Nathan campus)



(b) 2101ENG (GU-Gold Coast campus)



(c) 3101ENG (GU-Nathan campus)

Figure 1: Typical students' response to the question in the online survey

Actual correlation between students' remote engagement and their performance

Figure 2 presents the correlation between students' remote engagement (*i.e.*, using lecture recording) and their performance (*i.e.*, overall mark) in the selected analytical-based courses in different class sizes across the two universities. In this figure each mark with a specific colour represents a student in an analytical-based course. It is clear from this figure that approximately 50% or more students had less than 50% remote or online engagement and had received a "Pass" grade (overall mark of 50%) or higher, generally. Comparing this result with the results of the survey reveals a contradiction between students' perception of the lecture recording impact on their performance and the actual impact. In other words, majority of the participants believed that the lecture recording would enhance their learning and increase their marks; however, they rarely watched the recorded videos/engaged online.

Additionally, it can be seen from Figure 2 that significant number of students who received the overall mark of 85% or higher (*i.e.*, High Distinction) generally had less than 20% remote engagement. These students are usually active learners who prefer in-person attendance as a way to comprehend the concepts. This is witnessed by their relatively high in-person attendee shown in Figure 3. Students with lower overall marks, but passed the course, had more remote engagement.

It is also evident from Figure 2 that the number of students in small class sizes, who had more than 50% remote engagement, is more (*i.e.*, more than 30%) compared to large class sizes. Approximately, 6% of these students failed the courses.

Figure 3 shows the typical correlation between students' in-person engagement (*i.e.*, face-to-face engagement) and their performance (*i.e.*, overall mark) in the selected analytical-based courses in different class sizes. In this figure each mark with a specific colour represents a student in an analytical-based course. It can be observed from this figure that in general there is a positive correlation between students' in-person engagement and their overall marks. A raft of research supports such a relationship (Golding, 2011; Newman-Ford et al., 2008). Overall, more than 40% of students had attended the lectures and had received a "Pass" grade or higher. Additionally, it can be seen from Figure 3 that significant number of students who received the overall mark of 65% and higher (*i.e.*, Credit, Distinction and High Distinction)

had more than 50% in-person engagement. Students' with overall marks of 50% to 65% had a range of 0% to 95% in-person attendance. According to Figure 3, there is no significant difference between the results of small and large class sizes.

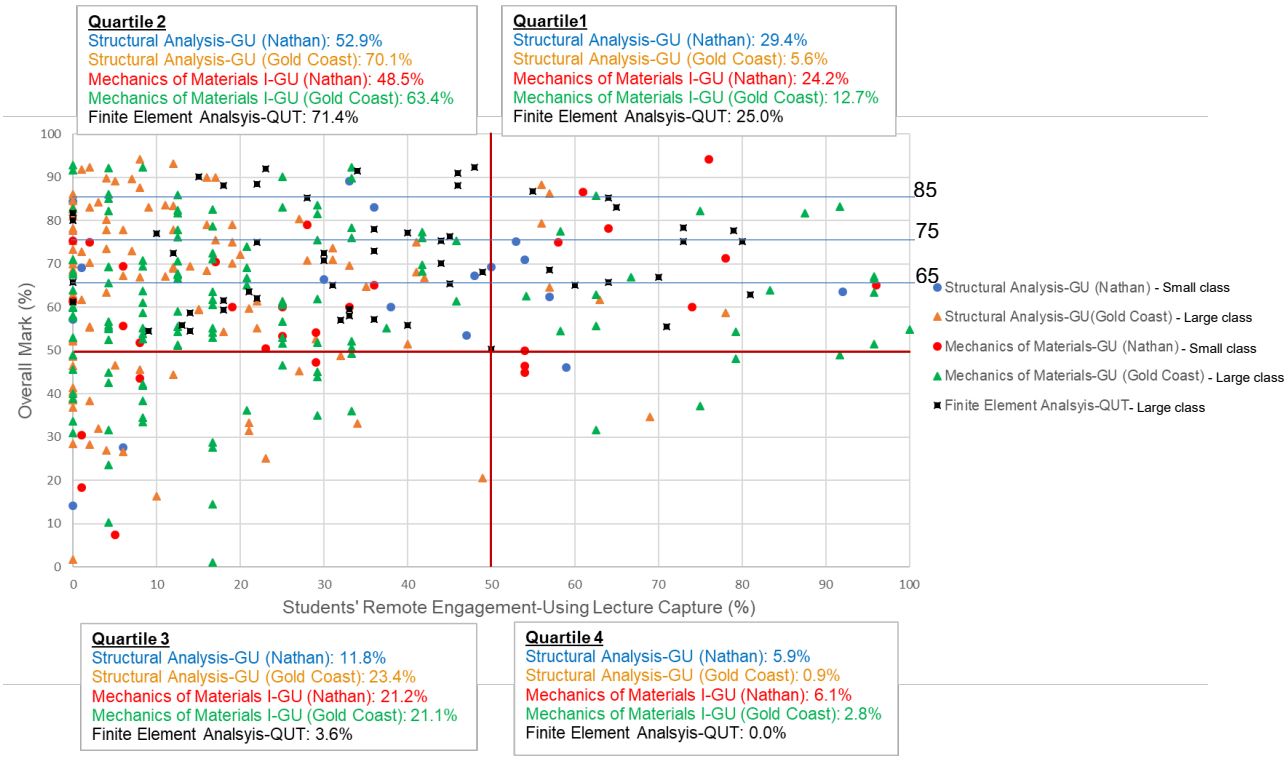


Figure 2: Correlation between students' remote engagement and their performance

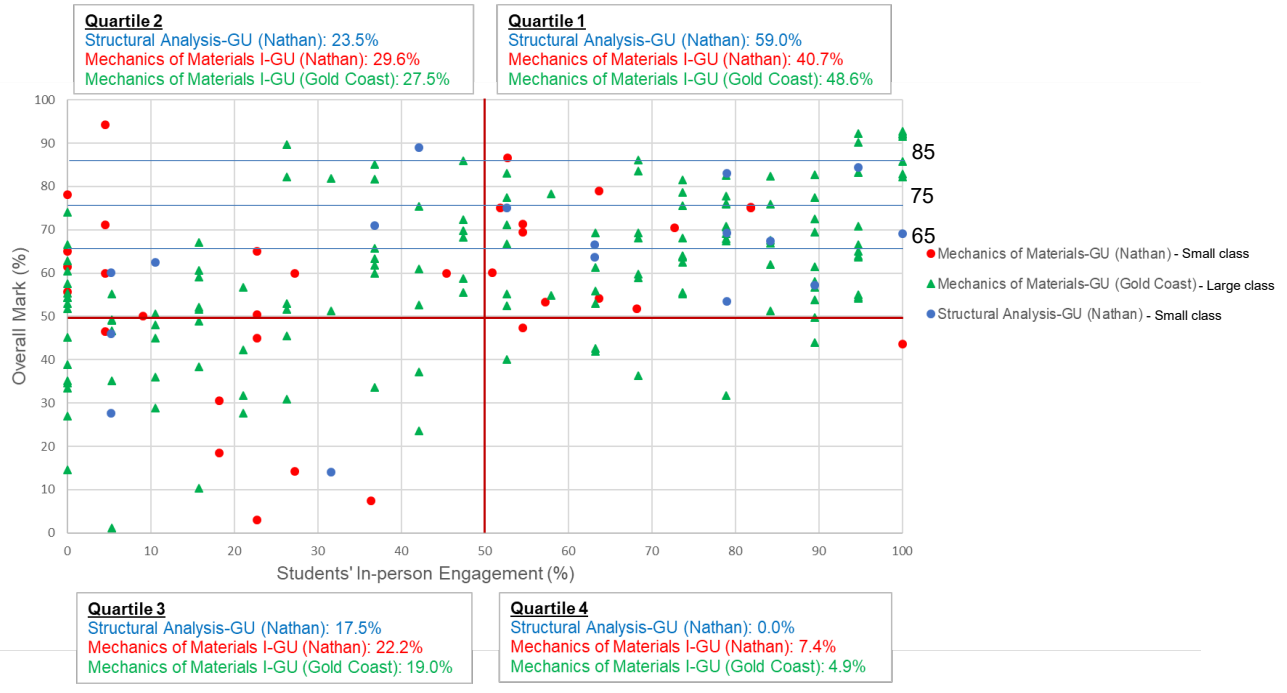


Figure 3: Typical correlation between students' attendance and their performance

Comparing Figures 2 and 3 reveals that, given the limitations of the lecture recording and the nature of the Engineering analytical-based courses, which involve experiential learning and/or group discussions and activities, a significant number of current students, who received the "Pass" grade or higher, would prefer face-to face engagement. Given the significant growth in online learning, this result concludes that while efforts should be made to continually improve

students' learning through experiential/active approaches, attention should be made to improve the capacity and sophistication of the lecture recording. Capturing from a camera facing the instructors while they carry out the experiments or playing a pre-recorded demonstration, which can be recorded by the lecture recording (Echo360), while they conduct experiments during the lecture would be some options to consider.

Figure 4 presents the week-by-week pattern of students' in-person and remote engagement for Mechanics of Materials I at Nathan campus. This figure was chosen as a typical example. It can be observed from this figure that in general students' in-person attendance is higher than remote engagement. Additionally, one can conclude that the students' in-person attendance pattern does not follow that of students' remote engagement. Whilst, the students' in-person attendance has approximately three peaks (at the beginning (Week 1), middle (Week 5) and end (Week 11) of the Trimester), the students' remote engagement has one peak (middle of the Trimester (Week 4)). Apart from a single peak, the students' remote engagement is relatively constant. It is believed that students' in-person attendance is at highset at the beginning of the Trimester as students would like to know more about the general course rules, contents and assessments covered in the first lecture. The subsequent peaks are around the assessments' due date.

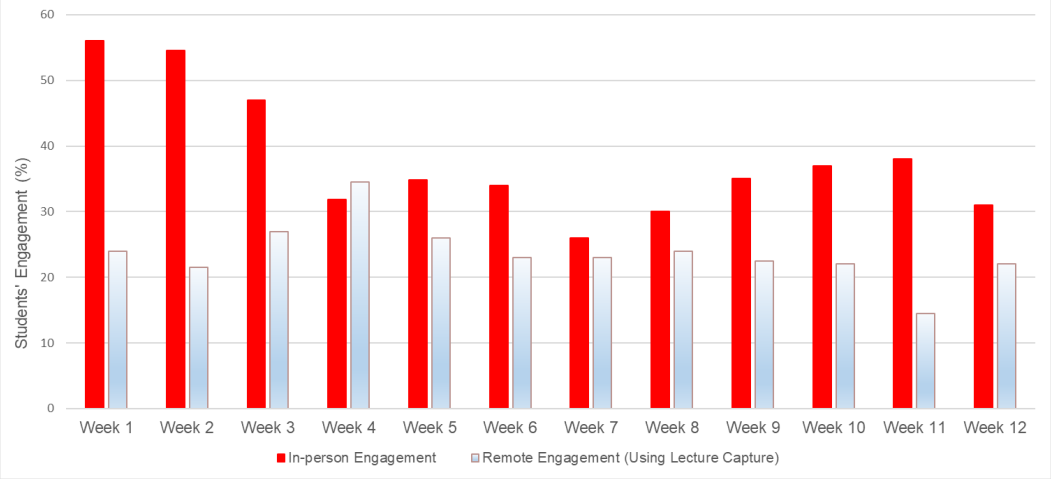


Figure 4: Typical week-by-week pattern of students' in-person and remote engagement (2101ENG at Nathan campus)

Conclusion

This paper presents the findings of a study that has been conducted at Griffith University in collaboration with Queensland University of Technology. The main aim of this study was to investigate the correlation between Engineering students' perception and the use of lecture recording, and their performance in different classroom sizes with the view of improving lecture recording features and students' success. The outcomes of this study are as follows:

- Whilst the results of online survey revealed that more than 70% of participated students either agree or strongly agree that the recorded lecture would assist their learning and performance, the quantitative results (using students' analytic results and overall marks) showed approximately 50% or more students had less than 50% remote engagement and had received a "Pass" grade or higher.
- High achieving students (overall marks of 85% or higher) had less than 20% remote engagement, generally. The results showed that such students are active learners who prefer in-person attendance as a way to comprehend the concepts. Students' with lower overall marks, who passed the course, had more remote engagement.
- The number of students in small class sizes, who had more than 50% remote engagement, is more compared to that in large class sizes.

- Given the limitations of the lecture recording and the nature of the Engineering analytical-based courses which involve experiential learning and/or group discussions and activities, significant number of current students, who received the “Pass” grade or higher, would prefer face-to face engagement.
- Based on the results, it is believed that the students should be encouraged to attend the lecture in-person and be actively involved in group discussions/activities to comprehend the concepts and hence achieve higher marks. However, the need of having lecture recording for students, who could not attend the lecture in-person due to various reasons should be recognised. The current lecture recording methods cannot fully satisfy such need as they are not able to record the in-class experiments/demonstrations. Therefore, attention should be made to improve the capacity and sophistication of the lecture recording to support such students to learn and achieve higher mark.

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