

Impact of Blended Learning on Engineering Student Attendance Post COVID-19

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Abstract— This paper aims at exploring the impact of applying a blended learning approach on the classroom attendance of engineering students post COVID-19. In this study, an interactive e-learning teaching approach, including synchronous online teaching delivery, was used as an alternative option in addition to regular face-to-face teaching. This approach was offered to all students attending two engineering modules, whether being still stranded off-campus or couldn't participate face-to-face for any reason. The major research question of this study is: given that engineering modules can be delivered effectively and interactively online, how will this affect student face-to-face attendance in the classroom? All students who attended the modules were asked to complete a quantitative survey where they could give their views on the quality of the tuition they had received and their opinions on the effectiveness of the online delivery. Evaluative data was obtained from a variety of means to provide a coherent case study. The paper presents comments and feedback from the students and some proposed implications for engineering student attendance when alternative online module delivery is an option. The outcomes of this study could help to inform pedagogies for future engineering education.

Keywords—Blended Education, Interactive E-learning, Engineering Education, Student Attendance, Student Engagement

I. INTRODUCTION

In response to the COVID-19 pandemic, almost all universities around the globe have adopted some sort of e-learning approach to maintaining their delivery [1]. The epidemic firstly happened in China around the Spring Festival and winter break, which was a challenge to the universities in China. The extreme challenge was to international universities in China, as many of their international staff and students were abroad. Although some of the international staff were able to return on campus, the majority were stranded away due to travel restrictions and border closure. Additionally, all overseas students couldn't return, and even domestic students in China were not allowed to return to campus for several weeks [2]. Some universities were able to respond with their proposed e-learning approach immediately amidst the pandemic [3-4]. Other universities had to delay the semester for a while. In general, universities have used "the best we can" as their online teaching strategy [5]. There was a wide spectrum of online learning approaches that were used at different universities [6]. This variation was due to multiple factors, including the platform availability, online teaching facilities, the extra workload for lecturers to prepare for online teaching. The network speed at the students' side was an important issue as well, especially if the fact that students were scattered in different regions is considered [7]. On the other hand, student engagement was another major issue [8].

Most of the universities were already using Virtual Learning Environment (VLE) platforms before the pandemic, which could also be considered as a part of online learning. At the University of Nottingham Ningbo China (UNNC), where this study was conducted, the encouraging online approach across the campus amidst the pandemic was prerecording lectures in the form of videos and sharing them with the students through, Moodle, the official VLE. With that approach, the semester has been successfully started after a couple of weeks of delay. The major limitation was the lack of interaction with students in general and engineering students in particular due to the nature of some of the engineering programs of study. However, there has been a good practice adopted during the epidemic as an effective online approach, in which synchronized teaching was implemented in all teaching activities since the beginning of the semester [9]. This included lectures, seminars, pastoral care tutorials, and, where needed, one-to-one academic tutorials. Later on, this effective approach was encouraged across the campus to maintain the quality of teaching delivery to international students who are still stranded away.

Moving forward, such an experience of online teaching during the pandemic has enlightened the teaching and learning authority on campus to think about the necessity of extending the blended educational model and moving rapidly towards a wider digital transformation. This has motivated the proposed study to investigate the effect of using such a blended educational approach on classroom attendance, especially engineering students, after all domestic students were able to return to campus and resume face-to-face teaching as usual.

Before the pandemic, some of the published research investigated student engagement and classroom attendance, where the lecture was recorded or captured [10-11]. Considering that blended learning is highly likely to be used in a wide range in higher education as a new normal, it is necessary to investigate how blended learning could affect student engagement and classroom attendance post COVID-19 pandemic. Following this introduction, the rest of the paper is structured as follows: Section II offers a brief literature review mentioned in this paper on blended learning in higher education, lecture capture, and its potential impact on student attendance. Section III explains the teaching delivery of the two engineering modules used in this study, pre, and post-pandemic. Section IV presents the methodology employed to develop the study. Section V then demonstrates the findings. Finally, section VI concludes.

II. LITERATURE REVIEW

Blended learning has seen widespread adoption in the past two decades in higher education [12, 13]. Recently it became a necessity during the COVID-19 pandemic [1]. This trend of adoption is expected to grow in the future post-pandemic [5]

further. E-learning can be an extremely effective component of blended learning in which a portion of the course content is delivered online. A study focused on e-learning aspects of blended learning has provided a brief overview of the fundamental issues that must be considered when designing a blended learning course [14]. A review study of the factors affecting e-learning and blended learning showed that, among the many factors, educator presence in online settings, interactions between students, teachers, and content, and designed connections between online and offline activities, as well as between campus-related and practice-related activities, seem to dominate more [15]. A study that looked at recent Internet activities and literacy in relation to Internet behavior and online learning highlighted milestones in terms of recent issues, challenges, and trends in Internet activities, with a focus on online learning and its potential in the big data era [16]. The impact of online learning on both continuing education for graduate engineers and degree-seeking engineering students, as well as its quality, scale, and breadth, has been discussed in [17]. A recent study looked into the main factors that encourage the use of e-learning systems during the COVID-19 pandemic, as well as the critical challenges that current e-learning systems face [18]. Before the pandemic, there were a number of studies that have addressed the effect of capturing the lectures. While some of the studies investigated student's engagement and attendance [19], other studies highlighted how students could benefit from a specific part of the video or repeat some parts, which could be difficult for them [20, 21]. On the other hand, there was some doubt as to whether this is a universally beneficial development for students, and expected disadvantages of lecture capturing have also been investigated, including concerns on the impact of student attendance [22]. Despite the availability of online class notes, a study found that class attendance is highly correlated with academic achievement [23]. The same study also discovered a link between class attendance and outside-of-class contact with lecturers, as well as a link between first-year university performance, current academic success, and class attendance. Another study found that a great majority of learners thought that the recorded lecture was unattractive and uninteresting after having a quick look at the general information of the course [24]. The net effect of lecture capture introduction on the cohort is generally found negative, according to a study that looked at the effects of lecture capture introduction and usage in a required second-year research techniques module in an undergraduate BSc degree [10].

To the best of the author's knowledge, no existing studies have explored the impact of the future use of blended learning on classroom attendance post-pandemic. Unlike a study that used a quiz or an assignment during the pandemic to obtain student attendance and declared was well received by students [25], or a one that indicated students felt stressed or uncomfortable with online classes [26]; the novelty of the study presented in this paper includes the impact of blended learning on classroom attendance when e-learning is not used to replace face-to-face teaching, but offered as an alternative option.

III. TEACHING DELIVERY

A. Standard Module Delivery

Two final-year optional engineering modules were used to carry this study, EEEE3069 Digital Communications, and EEEE3070 Embedded Computing. Each module is worth 10-

credit out of 120-credit students have to complete in their final year of study. The two modules belong to the Electrical and Electronic Engineering Program. The modules were offered among a list of level-3 optional modules to students from two different degrees, namely: BEng in Electrical and Electronic Engineering, and BEng in Mechatronic Engineering. These modules are taught in one semester of study over eleven weeks of teaching in addition to a revision week followed by a final exam period of three weeks. The first two teaching weeks are considered a change of mind period, during which, although students could attend the modules, they have the right to replace their preregistered modules with other optional modules, where possible. This means that attendance in the first two weeks of the semester is not compulsory, as sometimes teaching sessions of different optional modules conflict. Teaching sessions include a weekly two hours lecture for each module. One module has a weekly seminar of an hour length, while the seminar of the other module starts from teaching week five on a weekly basis, and it lasts one hour as well.

B. General Teaching Arrangement Post the Pandemic

Post COVID-19 pandemic, since the majority of UNNC students are domestic, all of them were able to return to campus as normal. Accordingly, teaching activities of all modules were planned to be delivered as normal, face-to-face, in the autumn semester of 2020 when this study has been performed. However, since overseas staff and students who are stranded aboard could not return to China due to travel restrictions; therefore the campus teaching and learning committee has decided that a blended learning model has to be used in UNNC, to accommodate overseas students and teaching staff. It was agreed that a minimum threshold for engagement with the official VLE (Moodle) which all modules must meet, with the following requirements added before the beginning of the academic year:

- Where possible, live lectures with lecture capture were strongly encouraged for on-campus teaching staff. If lecture capture is not possible, prerecorded lectures for overseas students should be uploaded to Moodle before seminars.
- Prerecorded lectures are divided into small segments and made as interactive and engaging as possible to meet the conditions for low-speed internet connection.
- A delegated online session for overseas students must be used for workshops or highly interactive sessions where lecture capture is not possible.
- There must be dedicated seminar sessions (preferably synchronized) for overseas students; however, recorded seminars are not required and are left to the discretion of the teaching staff.
- For existing overseas teaching staff, either prerecorded lectures to be uploaded to Moodle or synchronous lectures to be conducted with all students. Live seminars are required in this case, but recording is up to the teaching staff.

C. Teaching Adjustment for an Alternative Online Classroom

Without limiting the general requirements and guidelines mentioned in the previous section, a fully synchronous online teaching approach was used for the teaching

delivery of the two engineering modules used in this study. In order to make this approach as interactive as possible, a variety of teaching tools were used. Besides Moodle, MS-Teams was added to facilitate instant interaction with students and office hours. Zoom was used for live class sessions delivered on MS Tablet equipped with digital ink. PowerPoint was used to produce prerecorded lectures with a satisfactory resolution and reasonable video file size. A video editing software was used for editing any of the prerecorded lectures where required. Homework exercises were moved online to ensure that there was sufficient advice and pastoral care. In addition to Moodle, another video learning platform (Panopto) was used. Online teaching delivery was offered to all students attending the modules, whether being still stranded off-campus, or couldn't attend one or more teaching activity in face to face, for any reason, a way to give students the option to attend from anywhere they are.

IV. METHODOLOGY

In total, 37 students enrolled in the two modules, including three overseas students located in different time zones. Domestic students were informed, they have the full freedom if they prefer not to attend any of the teaching sessions face-to-face and choose to attend the streamed session instead. Most importantly, they were assured they didn't have to justify the reason for doing that. In order to maintain seriousness, a guideline document for how to log in to, Zoom, with the university account was published on Moodle. Students were also told to turn their cameras and microphones on during the entire session if they chose to attend online. All lectures and seminars throughout the entire semester were streamed from the classroom on, Zoom, recorded, and then published on, Panopto, with a link of each video embedded on Moodle, together with the relevant teaching material and readings to the taught topic that was published before the class. Digital ink was used to annotate the lecture slides. The traditional whiteboard in the classroom was replaced with an electronic whiteboard on the tablet device and was displayed on a few big screens in the classroom. The electronic whiteboard was captured during each class as part of the published video. Additionally, a screenshot of the electronic whiteboard of each session was saved as an image and shared on, Moodle, right after the teaching session together with the video captured session. The right half of each shared whiteboard was left intentionally blank to help students adding their own notes and comments on each captured whiteboard file.

The study was firstly approved by the research ethics committee at the faculty of science and engineering. All the students attending the two modules were asked to complete a quantitative survey where they were able to give their views on the quality of the tuition they had received and their opinions on the effectiveness of the online delivery. The survey included 20 questions in total, with 16 Likert questions and four open questions. Microsoft Forms was the platform used to build and analyze the survey. The survey included a few questions to learn about the student experience of online learning before performing this study, with the rest of the questions to learn about the experience of the students after applying this blended learning approach. The response rate to the survey was around 75%. Evaluative data was obtained from a variety of means in order to provide a coherent case study. The responses were analyzed using simple statistics

together with the student responses from the open question fields to derive meaning from the results.

V. FINDINGS

Figure 1 shows that 28 students in total have responded to the survey. Out of which 3 students were stranded overseas for fully online attendance, with a response rate of 100% of overseas students. Another 25 students of the onsite students have engaged, with a total response rate of 75%. Figure 2 shows the number of students who responded to the survey from each individual program with a response rate of 57% from Electrical and Electronic Engineering, and 43% from Mechatronic Engineering. 50% of students out of the total response have attended the Embedded Computing module. Nearly 29% have attended the Digital Communications module, while the rest (~21%) have attended both modules as per Fig. 3.

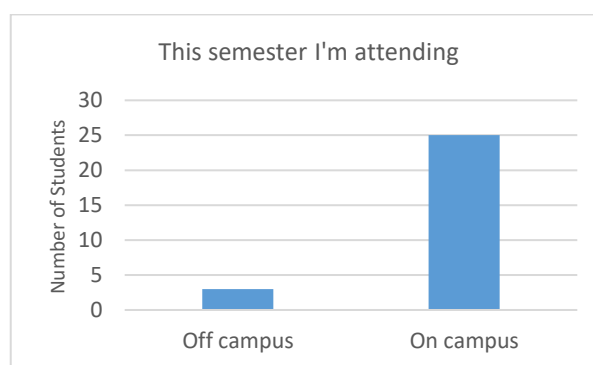


Fig. 1. Mode of attendance.

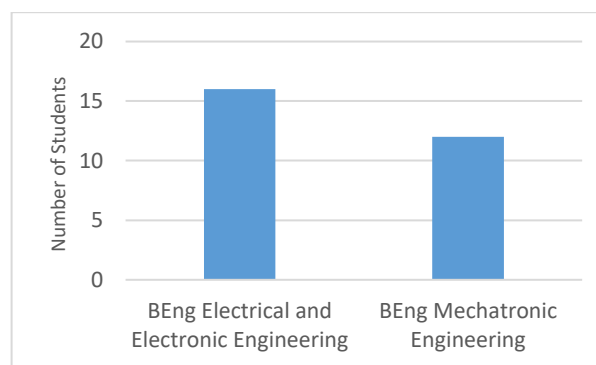


Fig. 2. Program of Study.

A. Reasons affecting classroom attendance

The investigator was firstly interested to know if students usually attend the class and whether there are reasons that may attract them to attend. As their response shows in Fig. 4, 96% of the students confirmed that they attend most of the teaching sessions, including lectures and seminars, unless they are sick or have urgent reasons arise. The rest responded that their attendance is based on their view of the teaching quality of the lecturer. Unexpectedly, none of the students responded that they would attend the lecture only if it's relevant to an assessment task, nor their attendance depends on social and work commitments. They further explained that, in general, potential reasons for their absence from the class could be due to sickness, getting up late when the class is scheduled early in the morning, especially when they sleep late, or when they

think they will arrive late at the class venue. Other urgent reasons could be due to unexpected injuries, or when they go off campus to take a test at a testing center, or due to severe weather conditions.

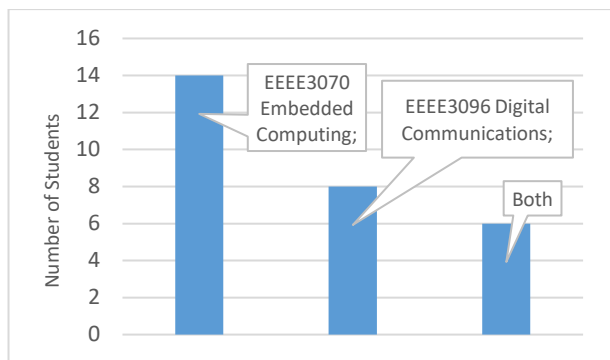


Fig. 3. Modules of attendance.

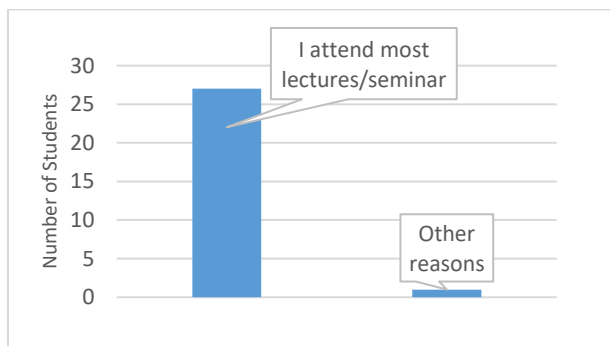


Fig. 4. Reasons for attendance.

B. Students' previous experience with online teaching

In order to explore how much experience have students had with online teaching before this study, they were asked about the number of previous modules they have been enrolled into where live streaming of the lectures was used. Although this study was made post the pandemic in China, the response to the question varies. As shown in Fig. 5, 29% of the students said that more than three modules have previously used synchronous teaching in terms of live streaming during the pandemic. 60% have of the students have previously attended live lectures in their modules, while the rest (11%) haven't had prior experience of live streaming of the lectures. The difference in the module number is because during the semester when the pandemic happened in China, streaming of the lectures was not mandated; although, it was encouraged.

The students were also asked about the number of previous modules they have been enrolled in that used prerecorded lectures. As their response shows in Fig. 6, 86% of students had experienced prerecorded lectures when the pandemic firstly happened in China. Students further explained that they hadn't had a good experience with their online learning, as some of the modules have used the lecture slides with voice-over, and it felt like just reading the PowerPoint slides. Reasons for not having a high-quality online delivery of some modules were due to the fact that some lecturers and all students were not on campus during the pandemic, which means that the issue has been handled with limited resources. Some students also mentioned, they couldn't concentrate for a

long period of time as they felt that some of the online classes during the semester of the pandemic were not engaging enough.

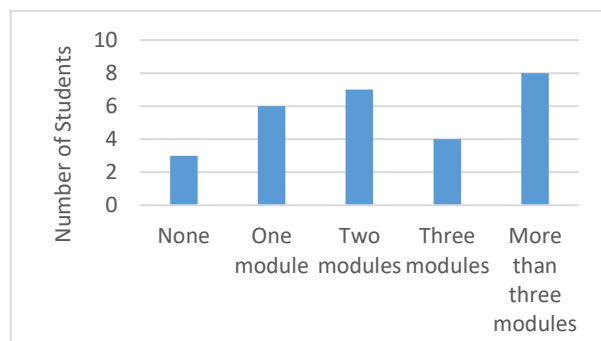


Fig. 5. Previous experience of streamed lectures.

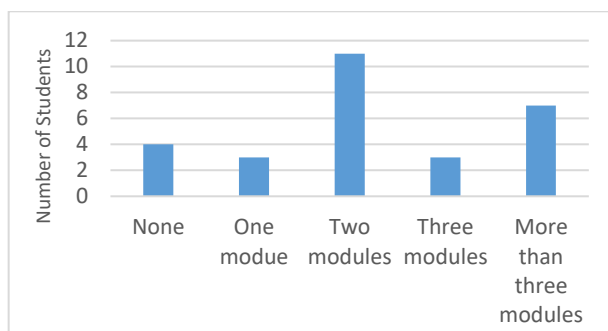


Fig. 6. Previous experience of prerecorded lectures.

C. Alternative online class effectiveness compared to face-to-face teaching.

To investigate how useful the online class used in this study is, compared to the usual face-to-face teaching in the view of the students, they were asked how useful they consider the streamed lecture to be compared to face-to-face teaching. The response is shown in Fig. 7 where 47% of the students think it's either very useful or somewhat useful, while 39% see it neither useful nor not useful. None of the students think the streamed lectures were not useful, even though it was also interesting to see that 14% think they were somewhat not useful to them. On the other hand, when the students were asked how useful they considered the captured lectures to be, ~72% said the videos were either useful or very useful as shown in Fig. 8. It was also interesting to see that 4% think that the lecture capture is not useful; this's possibly because some students attend all classes and take their own notes as well.

D. Effectiveness of the online teaching approach used in this study.

In order to measure how effective the approach used in online teaching delivery is, students were asked, on a scale of 1 to 5 (1 is not useful and 5 is extremely useful):

How do you feel the use of the electronic whiteboard has improved your learning experience?

How do you think the lecturer annotations of the lecture slides have advanced your understanding of the content?

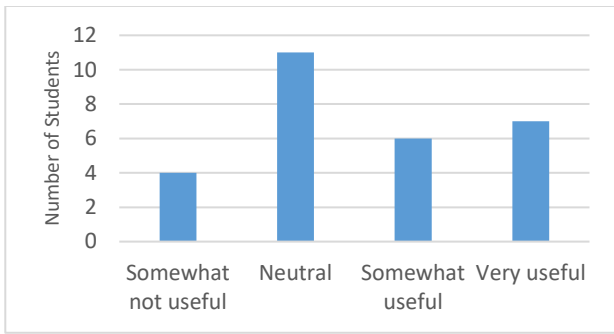


Fig. 7. Student view of the synchronous online teaching delivery.

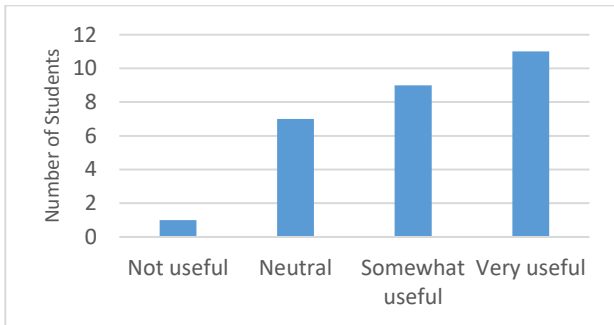


Fig. 8. Student view of the lecture capturing videos.

The results are demonstrated on Fig. 9 and Fig. 10. 79% of the students see that the electronic whiteboard is either useful or extremely useful, and it has improved their learning experience, while 82% of the students see that slide annotation of the lecture slides is either useful or extremely useful. These results reflect how students were happy with the synchronous teaching used in this study, compared with their previous experience.

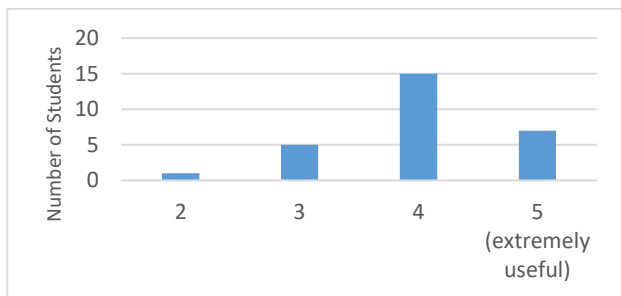


Fig. 9. Student view of the electronic whiteboard in synchronous teaching.

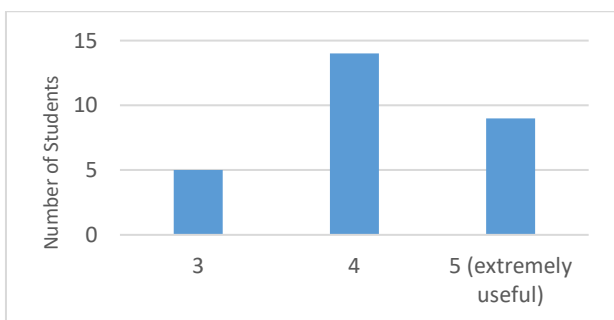


Fig. 10. Student view of lecture slide annotation.

E. Student attendance to the alternative online class

It was interesting to see how students will receive this opportunity of attending their classes online instead of being present in the classroom when they can choose. On the survey, the students were asked:

How many live classes (streamed on Zoom) have you attended of the modules (EEEE3069, EEEE3070)?

The online attendance varies, according to Fig. 11. However, it is obvious that students prefer to attend the face-to-face class in principle as 43% of them never even tried the alternative online attendance. 7% of the students have attended one session online. 11% attended two sessions online, 4% have attended three sessions online, 28% have decided to attend more than three classes online, but this included overseas students who haven't attended all their classes online (i.e., missed a few classes due to the time difference). The rest of the overseas students (7%) haven't missed any class, and clearly, they were all attended online. The results of this question are correlated with those demonstrated in Fig. 7, as probably those students who never tried to attend online have felt neutral when they were asked how useful they consider the streamed lectures to be, compared to face-to-face teaching. Clearly, the majority of the students who have attended more than three classes online see the live streaming as useful or very useful, as it helped them to engage and not miss the class when they couldn't attend face-to-face.

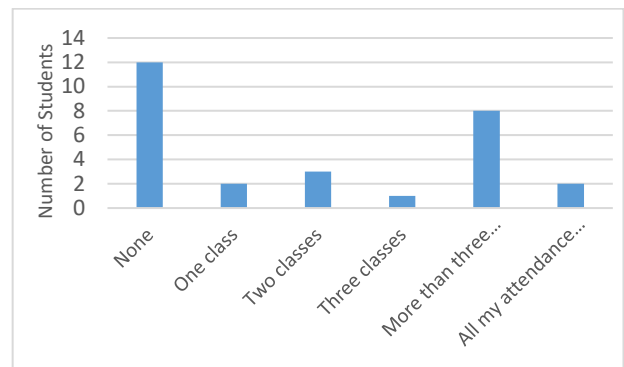


Fig. 11. Attendance of the alternative online class.

F. Impact of face-to-face attendance on student interaction.

The investigator was interested to see how likely face-to-face attendance would affect the interaction in the learning environment. To this end, the students were asked if they preferred to attend their modules face-to-face for better interaction with their lecturer. The response is shown in Fig. 12, where none of the students strongly disagreed or disagreed with the statement, while the vast majority (~89%) confirmed that they could interact better with the lecture face-to-face. Figure 13 also demonstrates the impact of face-to-face attendance on the interaction among classmates. Nearly 79% of the students stated that they prefer to attend the class face-to-face for better interaction with each other.

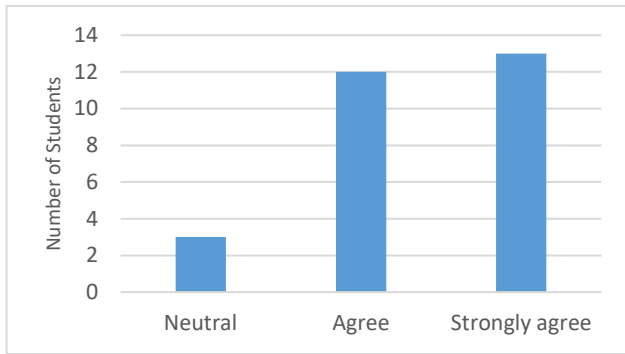


Fig. 12. Face-to-face attendance enhancement of the interaction with the lecturer.

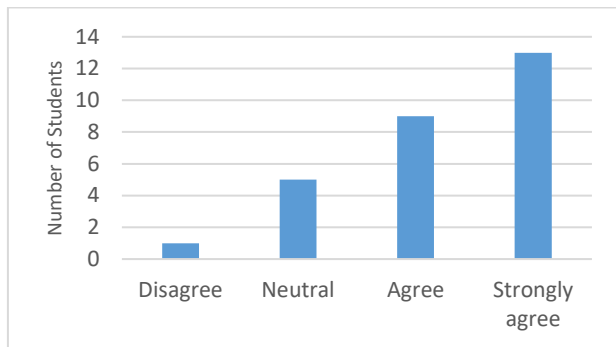


Fig. 13. Face-to-face attendance enhancement of the interaction with classmates.

G. Lecture capture

Since most, if not all, students were expected to use the recorded lectures after being streamed, it was important to investigate the student's experience of lecture capture in this study. To see how often they benefited from the recorded videos during the semester, students were asked to show their response on a scale from 1 to 5, where 1 corresponds to when they never watched the recorded videos and 5 for watching all the videos as shown in Fig 14.

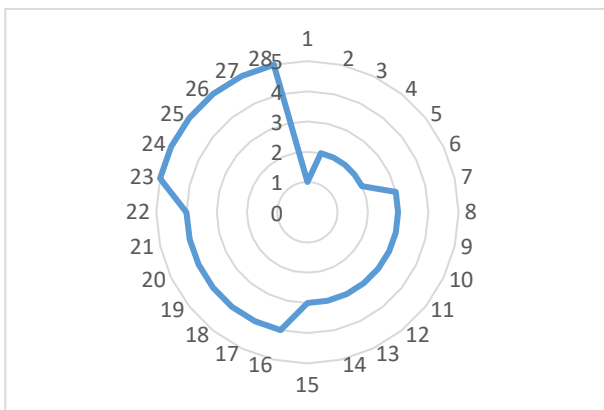


Fig. 14. Frequency of using the captured videos of the lectures.

More than 21% of the students have watched all the recorded videos. More than 57% of the students have watched the videos 60%-80% of the time, which clearly reflects the importance of lecture capturing to the students during the

entire semester. Another 17% of the students are less likely to watch the recorded videos, while it was still interesting to see someone who never watched the recorded videos, which is correlated with the results demonstrated previously in Fig. 8.

It was also important to investigate how lecture capture helps students' learning, no matter the frequency of which the videos have been watched. To this end, students were asked to explain their experience of the published videos of captured lectures (on Panapto) on a scale from 1 to 5 (1 means not helpful). As shown in Fig 15, the majority of the students (86%) have responded to the statement with a score of 4 or 5. This reflects how much the published recorded videos after streaming the sessions have improved students learning experience. The majority of the students gave very positive comments when they were asked to comment, reflecting their preference of having the lecture recorded and published after the class.

"Very recommended and useful for reference and refreshing ideas".

"The speed of the video could be adjusted so it's more beneficial to me".

Even some students who attended all classes still think that lecture capture made their learning easier.

"I had not planned to miss lectures but this was a proper means of easing my learning effort because I had saved records of each lecture".

Moreover, the recorded videos have helped students to review what they have learned, especially when they miss some point during the lecture or when the topic is difficult.

"Some unknown knowledge can be obtained by watching recording repeatedly"

Those comments are correlated with the results shown on Fig. 14 and Fig. 15.

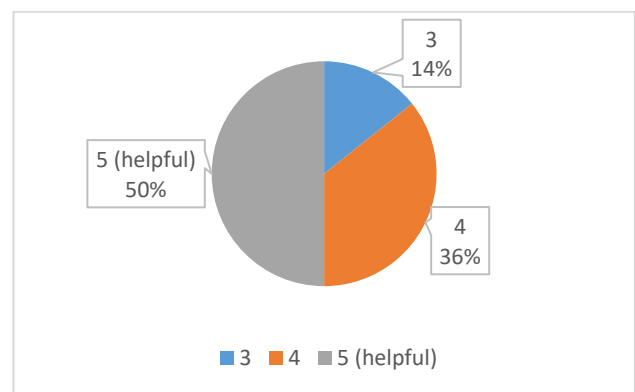


Fig. 15. Students view of the captured videos of the lectures.

H. Impact of lecture streaming and recording on face-to-face attendance

Finally, in an intervention where online attendance is being made as an alternative option to face-to-face teaching, given the fact that the two options of attendance are available in a blended learning model, it was interesting to investigate if students will continue attending all their classes face-to-face when the teaching sessions are streamed and recorded.

Surprisingly, as demonstrated in Fig. 16, around 86% of the students either agreed or strongly agreed to the statement. This is unlike some other results published in previous studies, where student attendance is a major concern when lecture capture is offered [10].

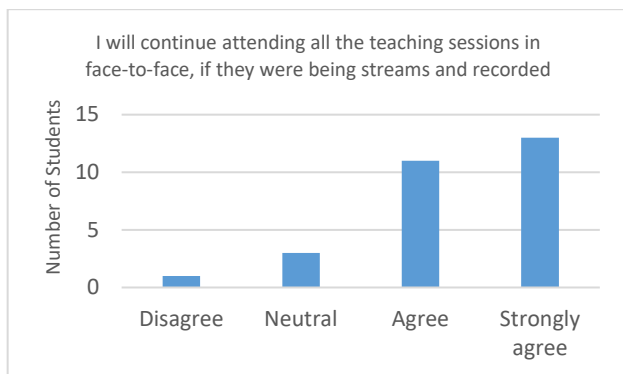


Fig. 16. Student preference of face-to-face attendance in the existence of an alternative online class.

VI. CONCLUSION

The paper has outlined the impact of extending blended learning post-COVID-19 pandemic on classroom face-to-face attendance in two engineering modules. A number of tools were implemented and evaluated to maintain the effectiveness of a synchronous online learning approach in terms of students' interaction and engagement. The model applied in this study is composed of two major components. Teaching session live streaming was used as an alternative option for student attendance instead of being present in the classroom. All teaching sessions, including the electronic whiteboard, were captured and published to students to facilitate their study. Unlike other online learning models, the one used in this study did not replace the normal face-to-face teaching, and students were given the freedom to choose to attend the classroom or not. The findings have suggested that applying blended learning where teaching sessions are captured or streamed and captured highly likely will not affect classroom attendance. The reason for that is students think face-to-face attendance improves the interaction among each other as well as between them and their lecturer.

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