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Patterns of university online teaching and learning delivery approaches and students' performance during COVID-19

Masitah Shahrill[1] · Elvynna Leong[2] · Daniel Asamoah[1] · Lin Naing[3] · Mohamad Iskandar Petra[4] · Jose H. Santos[2] · Anita B. Z. Abdul Aziz[3]

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Abstract

COVID-19 required new off-school technology-based learning environments for educational continuity. This study described the online delivery modes of lectures and tutorials in a university in Brunei Darussalam during COVID-19. A cross-sectional survey was conducted among 818 students from eight faculties. Data were collected through online surveys and analysed with descriptive and inferential statistics. The results show that students reported positive perceptions of online teaching and learning delivery modes. Online live lectures and tutorial sessions were the most frequent teaching and learning delivery modes, and these were reported more in health-related faculties. Our simple and multiple linear regression analyses showed that a strong positive perception of online teaching and learning delivery modes, using PowerPoint with audios and engaging students in online discussion forums tutorials were positively associated with student academic performance. The results imply that the online teaching and learning delivery modes adopted in crisis situations influence student satisfaction and academic performance. This study highlights why the use of multiple instructional delivery modes during crises can improve online teaching and learning.

Keywords Academic performance · Higher education · Online learning environments · Students' perceptions

✉ Masitah Shahrill
masitah.shahrill@ubd.edu.bn

[1] Sultan Hassanal Bolkiah Institute of Education, Universiti Brunei Darussalam, Bandar Seri Begawan, Brunei Darussalam

[2] Faculty of Science, Universiti Brunei Darussalam, Bandar Seri Begawan, Brunei Darussalam

[3] Pengiran Anak Puteri Rashidah Sa'adatul Bolkiah Institute of Health Sciences, Universiti Brunei Darussalam, Bandar Seri Begawan, Brunei Darussalam

[4] Faculty of Integrated Technologies, Universiti Brunei Darussalam, Bandar Seri Begawan, Brunei Darussalam

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Introduction

COVID-19 was declared a global pandemic by the World Health Organisation on March 11, 2020. Because of its severe and fast transmission, institutions in most countries, including educational institutions, were temporarily closed. In institutions of higher learning, on-campus events such as lectures, conferences, workshops, and sporting activities were either suspended or cancelled. Because stakeholders in higher education needed to develop long-term strategies to ensure educational continuity, there was a temporal shift from traditional face-to-face to remote emergency teaching and learning (Hodges & Barbour, 2021; Hodges et al., 2020).

Regardless of the pandemic's constraints, higher education instructors were compelled to develop and use alternative ways of teaching and learning (Theoret & Ming, 2020). The shift response towards this goal was to implement new off-school technology-based learning environments to promote teaching and learning. This resulted in online teaching and learning and sometimes blended learning. Because use of the Internet and the World Wide Web has increased, they served as a pedagogical context and provided rich media and resources that supported asynchronous and synchronous teacher–student communications (Means et al., 2009). This has made it possible to use relatively new online applications such as Google Classroom, Zoom, Google Meet, and YouTube to facilitate teaching and learning during the pandemic (Tuah & Naing, 2020; Simamora et al., 2020; Wu et al., 2021).

Therefore, instructors and students in higher education were compelled to use these media for teaching and learning. Students were required to develop and adapt the learning styles that supported effective learning. This has resulted in an increased interest in exploring the perceptions of educational stakeholders regarding the nature and effectiveness of these new technology-based online learning environments, as well as how students' performance has been influenced during this new shift.

The literature on instructional delivery during COVID-19 has produced mixed results in students' satisfaction with emergency teaching and learning. In some studies, students were satisfied and perceived online instructions positively (Amir et al., 2020; Obeidat et al., 2020; Yekefallah et al., 2021; Yough et al., 2023; Zhou & Hawrot, 2023). For example, Yough et al. (2023) argued that the perception of students about school climate contributed to their reading abilities. They also found that the teacher–student relationship in the school environment was a significant predictor of student grade point averages. Similarly, Zhou and Hawrot (2023) reported that a more positive perception of a school's climate is associated with higher achievement, interest, motivation, and satisfaction with school life. Conversely, students reported low satisfaction, were less motivated to engage in the new remote learning environment the pandemic required, and expressed negative emotions such as nervousness, aggression, and uncertainty (Murphy et al., 2020; Natarajan & Joseph, 2022; Stevanović et al., 2021).

Despite the contradictions in previous studies on how students are satisfied with remote teaching and learning, how students perceive these new learning environments in teaching and learning deliveries across disciplines, faculties, and departments, as well as how these environments influence their performance remain under-researched (Eurboonyanun et al., 2021; Refae et al., 2021), especially in the South-Eastern Asian context. Therefore, this study explored students' experiences in relation to the patterns of online teaching and learning during COVID-19. Specifically, the objectives were to explore: (a) the online delivery modes of lectures and tutorials, (b) the patterns of online delivery modes of lectures and tutorials across faculties, and (c) the effect on students' academic performance of

online delivery modes of lectures and tutorials and students' perception of these delivery modes.

Research questions

1. What are the prevalent online delivery modes of lectures and tutorials during COVID-19?
2. What are the differences in the online delivery modes of lectures and tutorials across faculties during COVID-19?
3. What is the effect on students' academic performance of online delivery modes for lectures and tutorials, and students' perception of these delivery modes during COVID-19?

Related work

Teaching and learning delivery modes

Appropriate learning environments are associated with higher students' self-efficacy (Lorsbach & Jinks, 1999), motivation and learning (Hanrahan, 1998). Therefore, further research on how teachers and students perceive and understand learning environments is quintessential (Levy et al., 2003). During COVID-19, higher education researchers and think tanks have continued exploring new technology-based instructional strategies to improve teaching and learning. Blended learning involving synchronous and asynchronous approaches has been the dominant pedagogical method (Moorhouse & Wong, 2022) because it enhances students' engagement and performance (Anthony et al., 2022; Jamil et al., 2022; Li et al., 2019; Thai et al., 2017; Zheng et al., 2021).

Synchronous modes provide a pedagogical context that allows teachers and students to meet simultaneously through online videoconference software, with teaching and learning being undertaken based on agreed times (Hysaj & Hamam, 2020). This mode of instructional delivery allows students to ask questions vocally or through live text messages. On the other hand, lectures can also be recorded in the form of videos or audio and uploaded on Learning Management Systems (LMS) or YouTube for students to access at their convenience. This is called asynchronous instruction (Gamage et al., 2020). In asynchronous learning, lecturers and students do not meet at the same time.

Both approaches to teaching and learning provide environments that facilitate students' discussions (Asamoah et al., 2022; Edward et al., 2018; Lapitan et al., 2021), and integrate offline and online instructional experiences for effective teaching and learning to occur (Martin et al., 2020). Their flipped component replaces face-to-face lectures and assignments with pre-recorded instructional activities so that class time is used for discussions and problem-solving (Olakanmi, 2017). Blended learning environments can also result in high student engagement and experience (Hodges et al., 2020; Kolb, 1984), which helps to train learners who understand, engage, and reflect on instructional activities (Sellnow-Richmond et al., 2020). For example, through live video lectures, such as Zoom, students can be put into groups to interact among themselves on a given task. They can also form online group chats to discuss instructional concepts. Engaging in live audio or video lectures encourages interactive conversations among lecturers and students, which can improve students' learning and understanding.

The literature highlights various pedagogical environments that promote teaching and learning delivery during COVID-19. The key among them is online platforms such as live video, audio, and pre-recorded lectures (Azlan et al., 2020; Magalhães et al., 2020). A study led by Elkhatat and Al-Muhtaseb (2021) concluded that instructors preferred to use hybrid online flipped instruction, which improved the learning outcomes of 46 students. Obeidat et al. (2020), in their research on teaching and learning during COVID-19, found that the most preferred e-learning delivery method was Microsoft Teams. According to them, students had convenient access to instructional content using Microsoft Teams from their mobile phones. Synchronous learning through live video conferencing platforms like Zoom and Google Meets has also been used in teaching and learning (Lapitan et al., 2021).

Furthermore, the use of asynchronous delivery modes has been established in the literature. The prevalent ones involve pre-recorded videos uploaded on the LMS and YouTube, which help students to learn at their pace (Abou-Khalil et al., 2021; Thai et al., 2017). A significant study of Murphy et al. (2020) with 148 undergraduate college students reported that instructors preferred to use LMS with virtual coursework components. Furthermore, Hysaj and Haman (2020) confirmed that most university academics resorted to online delivery methods through video and audio discussions and oral presentations, whereas a few used traditional face-to-face pedagogies.

It can be argued that online video lectures, pre-recorded videos, and audio lectures are the prevalent learning media during COVID-19. This is understandable in that blended learning can be convenient. In addition, the learning environment provided in blended platforms is associated with screen-sharing options, and lessons can be recorded and shared with students. However, some instructors used traditional face-to-face pedagogies during COVID-19. A possible explanation could be that traditional (i.e., face-to-face) learning environments could be suitable for practical courses that require in-person instruction.

Teaching and learning delivery, student perception, and academic performance

During COVID-19, blended instructional delivery modes through live video, audio lectures and tutorials have been the most preferred instructional space (Callo & Yazon, 2020; Muthuprasad et al., 2021; Rapanta et al., 2020; Schoenfeld-Tacher & Dorman, 2021). This is because most university students have found these pedagogical spaces to be flexible (Abisado et al., 2020; Azlan et al., 2020). The literature seems to suggest that students are satisfied and reported positive perceptions about the online blended learning environment (Hysaj & Hamam, 2020; Lapitan et al., 2021).

In a bid to establish how online teaching and learning delivery modes improve student learning, Alzahrani (2022) investigated online learning during COVID-19. He concluded that students' performance was higher when video conferencing and blackboard were used compared with only video conference. However, students reported a positive perception of video conferencing.

Equally important studies are the ones conducted by Refae et al. (2021) and Eurboonyanun et al. (2021). Refae and colleagues, in their research with 521 undergraduate students, concluded that students who were taught online performed better than their face-to-face teaching counterparts. They found that the number of weak students who received traditional face-to-face learning decreased when they were engaged in online video lessons.

Research conducted by Eurboonyanun and colleagues (2021) with 95 medical students concluded that those who received online video lessons and sat for online open-book

examinations performed better in their grade point average in both multiple-choice and essay questions than their face-to-face peers, who experienced traditional learning environments. Similar results that confirm that blended learning is associated with higher student achievement and engagement during COVID-19 have been shared by Anthony et al. (2022) and Elkhatat and Al-Muhtaseb (2021).

It is not surprising that most university students reported higher performance when they are engaged in online teaching and learning. In their research, Thai et al. (2017) reported that university students developed a better perception of teaching and learning when lecturers used pre-recorded videos, live tutorials, and live videos. These instructional delivery modes exposed students to instructional content before live class sessions. Students become aware of the lessons before the actual class that could clarify their doubts. Online live video and audio instruction and tutorials also improved peer support (Alashwal, 2020; Hilliam & Vines, 2021).

Conversely, there is a paucity of studies that suggest that students are less satisfied with online learning environments during COVID-19. In a bid to explore the dissatisfaction of students about emergency teaching and learning, Amir et al. (2020) surveyed 301 undergraduate university students to examine the nature of teaching and learning during COVID-19 and provided important insights. They concluded that students preferred face-to-face classrooms because remote learning limited their engagement in classroom discussions. Relatedly, studies by Stevanović et al. (2021) and Yekefallah et al. (2021) concluded that most students are unsatisfied with e-learning because they are less motivated and interested in engaging in it.

The literature demonstrates that an online learning environment provided the medium in which teaching and learning occur during COVID-19. The perception of students and their academic performance have also been influenced by certain online teaching and learning modes. However, it is unclear whether university students are satisfied with online teaching and learning delivery modes during COVID-19. In addition, the online instructional space implemented across different disciplines and faculties remains under-researched. Our literature review highlighted that previous research on the nature of online teaching and learning delivery modes in higher education during COVID-19 has involved medical and nursing education and neglected other disciplines. It is essential to explore the patterns of teaching and learning deliveries, students' perceptions, and how students' learning has been influenced by these delivery modes across faculties and disciplines. This is likely to help instructors to provide the pedagogical environments that can meet the specific needs of students in crisis situations such as COVID-19.

Methods

Participants and setting

A cross-sectional survey was conducted from June to July 2020 among undergraduate and graduate students from eight faculties at Universiti Brunei Darussalam. The names of the faculties are listed here with their disciplines given in parentheses to describe each faculty: Faculty of Arts and Social Sciences (Arts & Social Sciences), Academy of Brunei Studies (Brunei Studies), School of Business and Economics (Business & Economics), Faculty of Science (Sciences), Pengiran Anak Puteri Rashidah Sa'adatul Bolkiah Institute of Health Sciences (Health Sciences), Faculty of Integrated Technologies (Integrated Technologies),

Centre for Lifelong Learning (Lifelong Learning), and Sultan Hassanal Bolkiah Institute of Education (Education).

Students who took at least one module in one faculty and sat for all required examinations in the January to May semester served as participants. A total of 818 respondents undergraduate and graduate students participated. Although we targeted 4477 eligible students, Krejcie and Morgan (1970) suggested, that for a population of 3000, a sample size of 341 is appropriate for meaningful generalisation. Therefore, the 818 out of 4477 students who conveniently responded to the survey were adequate for our analysis and inference.

Instrument

A self-developed online survey, pretested for validity and reliability, was set up on the Qualtrics data collection platform and used to collect data. The survey consisted of three main sections. The first section asked about the background of the students, the second section asked about the teaching and learning delivery mode(s) that students experienced during the semester, and the final section asked about students' experience with assessments. Table 1 presents examples of the survey items and scales.

Cronbach's alpha, which measures the internal consistency of the second and third sections of the online survey, was 0.72 and indicates satisfactory reliability (Pallant, 2010). This paper presents the data from the first and second sections of the questionnaire. We

Table 1 Examples of survey items and scales

Variable	Example(s) of items	Scale
Background information	Gender	Nominal: Male or Female
	Faculty	Nominal: Arts & Social Sciences, Brunei Studies, Business & Economics, Sciences, Health Sciences, Integrated Technologies, Lifelong Learning, and Education
	Number of modules, coursework modules and online examinations	Self-written by students
Teaching and learning	What is your overall opinion on online teaching and learning during the COVID-19 outbreak?	Rating scale—ordinal 1–very poor to 5–very good
	Indicate how frequently *lectures* have been changed to the following: (a) Online live lectures (b) Recorded video lectures (c) PowerPoint with audio lectures (d) Online discussion forum	1–least frequent to 4–most frequent
	Indicate how frequently *tutorials* have been changed to the following: (a) Online live tutorials (b) Online assignments and exercises (c) PowerPoint with audio tutorials (d) Online discussion forum	1–least frequent to 4–most frequent
Assessment	What is your overall opinion of coursework assessments during the COVID-19 outbreak?	1–very poor to 5–very good
	What is your overall opinion of online examinations during the COVID-19 outbreak?	1–very poor to 5–very good

obtained students' Grade Point Average (GPA) for the January to May 2020 semester through the University examination office to judge their performance. The university GPA scale ranged from 0 to 5.

Data collection

Prior to data collection, permissions were sought and obtained from the relevant leaders of the university management. An invitation link to participate in this study and the survey link were shared with the students through the university's student mass email. Immediately after clicking the link, students were presented with a participants' information sheet, followed by a consent form. By clicking the 'agree' button on the consent form, students were able to proceed with the survey within ten minutes. Participating students were asked to indicate their registration numbers because we needed their numbers to liaise with the officer in charge of examinations. This helped to ascertain the GPAs of the students who completed the online survey. Despite that this process did not encourage the anonymity of the survey, all collected information obtained was treated as confidential and used solely for this study. The identities of the participating students have been treated anonymously.

Data analysis

Data were analysed using R statistical software (version 4.0.2). Data were checked, organised, and categorised as necessary. Appropriate descriptive statistics were used to describe the participants' background characteristics. The frequency of teaching and learning delivery modes was identified using frequency counts and percentages. For the frequency of delivery modes across faculties, we used the frequency scores to compare with mean scores using the Kruskal–Wallis test. This non-parametric test helped to determine if there were statistically significant differences between three or more groups on a variable. The Shapiro-Wilks tests were used to test for normality.

To investigate the effect of online modes of delivery of lectures and tutorials, and students' perception of these modes of delivery on their academic performance, we used simple and multiple linear regression with a stepwise variable selection method. This helped to establish and examine the linear relationships between the predictor variables—students' perception of online instructional delivery and modes of delivery of lectures and tutorials—and the outcome variable of academic performance based on GPA (Tranmer et al., 2020). We presented the results with 95% Confidence Intervals (CIs) as appropriate. Statistical significance was considered when a p-value was less than 0.05. The dataset generated during the analysis is available upon reasonable request.

Results

Characteristics of respondents

Characteristics of the respondents were analysed in terms of gender, faculty, number of modules taken, GPA, and opinion about online teaching. Table 2 presents a summary of the respondents' background characteristics.

The results in Table 2 show that the majority of respondents were female (71.1%) and from the Sciences (29.5%) and Arts & Social Sciences (27.1%) faculties. This distribution was expected because, according to the data extracted from the examination office, there were more female (64.8%) than male (35.2%) students across all faculties in the university that particular year, except for Integrated Technologies. The average number of modules taken was 4.54 (SD = 0.94) and the mean GPA for the semester was 3.34 (SD = 0.66). Most students (89.8%) reported adequate, good, or very good perceptions of online teaching delivery during the pandemic, implying a generally positive perception of online teaching and learning delivery. The distribution of GPA is presented in Fig. 1. Most students attained GPAs ranging from 2.5 to 4.5; however, those who achieved a GPA of 3.0 to 3.5 were the majority (see Fig. 1).

Research Question 1: What are the prevalent online delivery modes of lectures and tutorials during COVID-19?

The modes of online delivery for lectures were online live lectures, recorded video lectures, PowerPoint with audio lectures, and online discussion forums. For tutorials, the online delivery modes were online live tutorials, online assignments and exercises, PowerPoint for tutorials, and online discussion forums. Students were asked to indicate how frequently lectures and tutorials were changed to these modes during COVID-19. A summary of the modes of online delivery for lectures and tutorials is presented in Fig. 2.

Most respondents ($n = 321$, 41.3%) chose 'online live lectures' as the most frequent mode of lecture delivery. This was followed by 'PowerPoint with audio' ($n = 134$, 17.4%) and 'online discussion forum' ($n = 133$, 17.2%). Most respondents ($n = 244$,

Table 2 Respondents' background summary

Characteristics	*n* (%)	Mean (SD)
Gender		
Male	236 (28.9)	
Female	582 (71.1)	
Faculty		
Arts & Social Sciences	225 (27.1)	
Brunei Studies	26 (3.1)	
Business & Economics	97 (11.7)	
Sciences	245 (29.5)	
Health Sciences	89 (10.7)	
Integrated Technologies	45 (5.4)	
Lifelong Learning	21 (2.5)	
Education	82 (9.9)	
No. of modules taken		4.54 (0.94)
GPA		3.34 (0.66)
Perception of online teaching and learning		
Very poor	14 (1.8)	
Poor	66 (8.4)	
Adequate	323 (41.1)	
Good	306 (39.0)	
Very good	76 (9.7)	

GPA grade point average

32.5%) experienced 'online live tutorials' as the most frequent tutorial mode. This was followed by an 'online discussion forum' ($n = 113$, 15.5%). These results indicate that the prevalent online delivery modes of lectures and tutorials during COVID-19 were online live lectures and tutorials.

Research Question 2: What are the differences in the online delivery modes of lectures and tutorials across faculties during COVID-19?

For the comparison of the delivery modes of lectures and tutorials by faculty, the Kruskal Wallis test was performed. The means for each delivery method were compared. Table 3 and Fig. 3 present the results.

Online live lectures, which were the prevalent delivery method, differed significantly in terms of its use across faculties (see Table 3 and Fig. 3). The means and standard deviations ranged from 2.45 to 3.39, and from 0.85 to 1.19, respectively, with $p < 0.01$. Online live lectures were mostly used by faculties related to Health Sciences (mean = 3.39, SD = 0.90), Education (mean = 3.18, SD = 1.19) and Lifelong Learning (mean = 3.05, SD = 0.89). Table 3 reveals that recorded videos and PowerPoint with audio were mostly used in Brunei Studies (mean = 2.36, SD = 0.95 and mean = 2.58, SD = 1.02, respectively) and Business & Economics (mean = 2.33, SD = 1.16 and mean = 2.32, SD = 1.12, respectively). Online discussions were used mostly in Lifelong Learning (mean = 2.65, SD = 1.18) and Education (mean = 2.46, SD = 1.24). The patterns of other deliveries are not very consistent, except for recorded video. The results indicate that faculties related to Health Sciences and Education mostly used online live lectures. Recorded videos and PowerPoints were mostly used by faculties related to Brunei Studies and Business & Economics. Online discussions were also used prevalently in Education and Lifelong Learning faculties. The Kruskal Wallis test was also performed to compare the means of the delivery modes for tutorials. Details of the analysis are presented in Table 4 and Fig. 4.

The results indicate that online live tutorials were prevalent but differed significantly based on how they were used in all faculties. The mean and standard deviation values

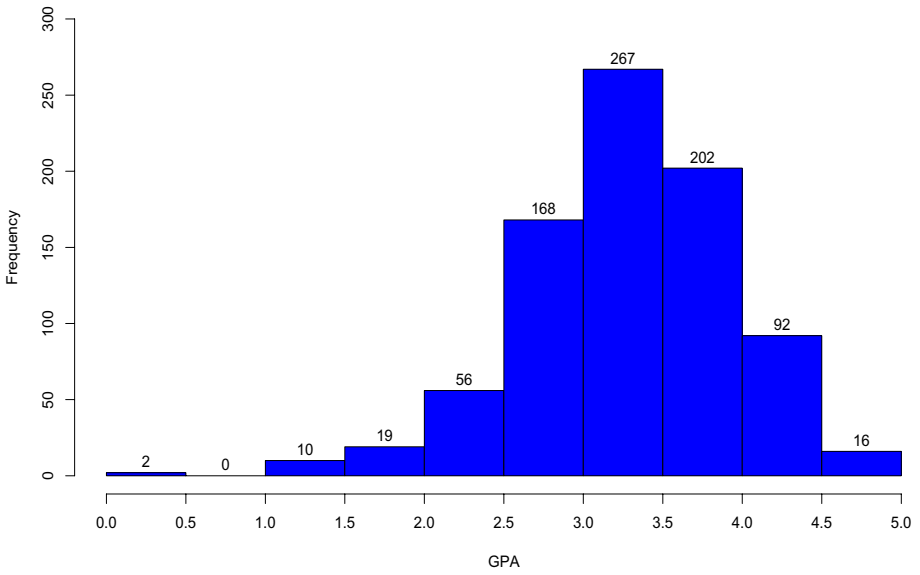

Fig. 1 Distribution of GPA of respondents in the January to May semester

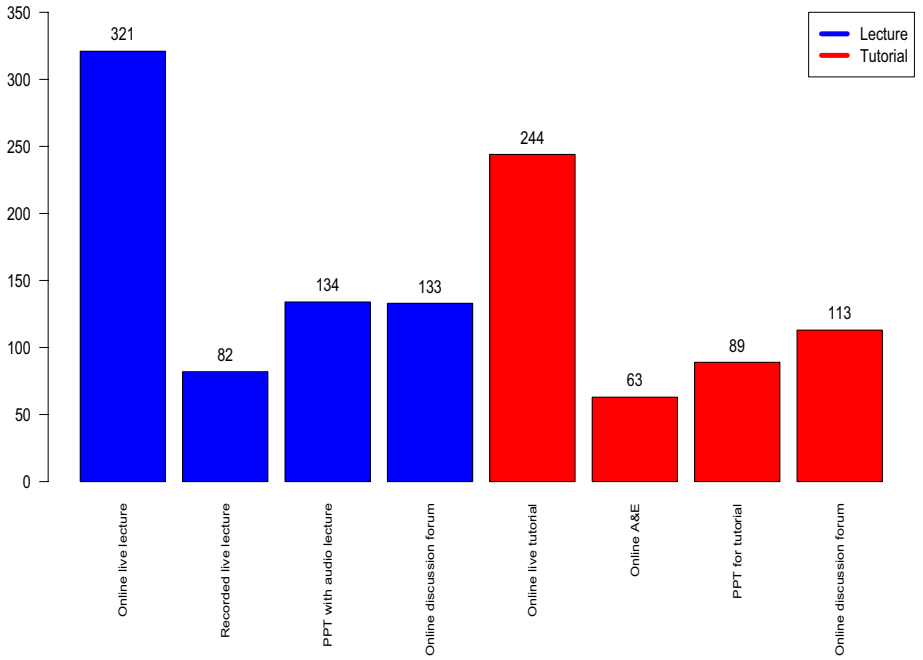

Fig. 2 Most frequent mode of online delivery of lectures and tutorials

ranged from 2.23 to 2.83, and from 1.09 to 1.35, respectively (see Table 4 and Fig. 4). Online live tutorials were mainly used in faculties related to Health Sciences (mean = 2.83, SD = 1.23), Sciences (mean = 2.68; SD = 1.23), Education (mean = 2.64, SD = 1.35), and Lifelong Learning (mean = 2.60, SD = 1.35). Online assignments and exercises for tutorials were mostly used in Brunei Studies (mean = 1.95, SD = 1.05) and Business & Economics (mean = 1.94, SD = 1.17) while PowerPoint was mostly used in Brunei Studies (mean = 2.14, SD = 0.94) and Arts & Social Sciences (mean = 2.05, SD = 1.17). Online discussions were mainly used in Lifelong Learning (mean = 2.42, SD = 1.12), Arts & Social Sciences (mean = 2.28, SD = 1.13), Business & Economics (mean = 2.17, SD = 1.13), and Education (mean = 2.12, SD = 1.22). Integrated Technologies had the lowest mean score for online live tutorials (mean = 2.23, SD = 1.16), PowerPoint (mean = 1.34, SD = 0.61), and online discussions (mean = 1.56, SD = 0.87) across faculties. The patterns of other tutorial deliveries were inconsistent, except that most faculties had the lowest mean scores for online assignments and exercises (see Fig. 4). From the results, live tutorials were mostly used in Health Sciences, Education, and Lifelong Learning faculties. Online assignments and exercises, as well as PowerPoints for the tutorials, were used in Brunei Studies and Business & Economics faculties. Online discussions were also used by faculties related to Arts & Social Sciences, Education, Business & Economics, and Lifelong Learning. Among the faculties, Integrated Technologies had the lowest mean scores for online live tutorials, PowerPoint, and online discussions.

Research Question 3: What is the effect on students' academic performance of online delivery modes for lectures and tutorials, and students' perception of these delivery modes during COVID-19?

Table 3 Methods of delivery of lecture by faculty

Faculty	Frequency ranking score (1–4)[a]			
	Mean (SD)			
	Online live lecture	Recorded video	PPT with audio	Online discussion
Arts & Social Sciences	2.88 (1.10)	1.82 (1.02)	2.26 (1.15)	2.36 (1.10)
Brunei Studies	2.68 (0.95)	2.36 (0.95)	2.58 (1.02)	2.24 (0.93)
Business & Economics	2.45 (1.13)	2.33 (1.16)	2.32 (1.12)	2.29 (1.10)
Sciences	2.98 (1.08)	2.02 (1.03)	2.10 (1.15)	2.07 (1.09)
Health Sciences	3.39 (0.90)	1.67 (0.88)	1.89 (0.97)	1.54 (0.89)
Integrated Technologies	2.93 (0.85)	2.14 (1.00)	2.02 (0.95)	1.84 (1.08)
Lifelong Learning	3.05 (0.89)	1.25 (0.64)	1.84 (1.26)	2.65 (1.18)
Education	3.18 (1.19)	1.75 (1.03)	1.99 (1.19)	2.46 (1.24)
p[b]	<0.001*	<0.001*	0.018*	<0.001*

NB: [a]Higher the score, more frequent; [b]Kruskal–Wallis test; *statistically significant ($p<0.05$); PPT: PowerPoint

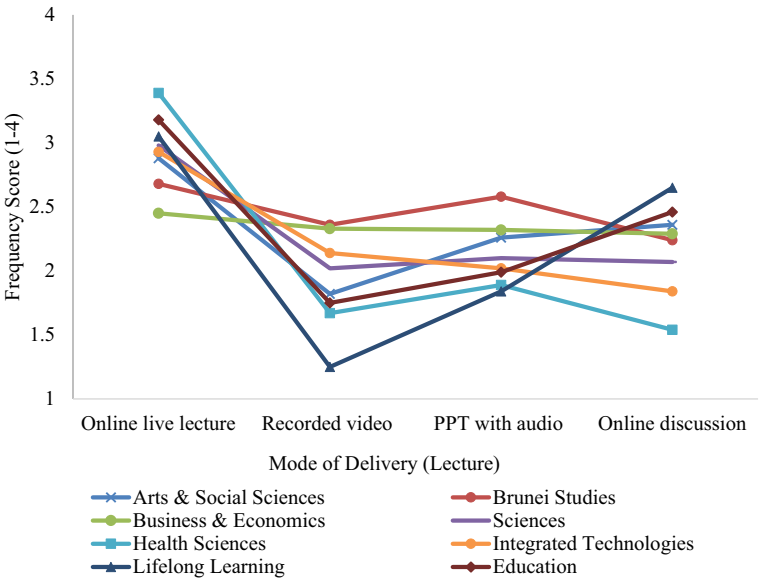

Fig. 3 Comparison of faculties on the mode of online delivery of lectures

A summary of the analysis on the effect on students' academic performance (based on GPA) of online delivery modes for lectures and tutorials, and students' perception of these delivery modes is presented in Table 5.

Table 5 shows that perceiving online instructional delivery positively (i.e., very good) was positively and significantly associated with academic performance ($\beta=0.59$, $p=0.043$). Moreover, experiencing PowerPoint with audio lectures was positively and

Table 4 Methods of delivery of tutorial by faculty

Faculty	Frequency ranking score (1–4)[a]			
	Mean (SD)			
	Online live tutorial	Online assignment and exercises	PPT for tutorial	Online discussion
Arts & Social Sciences	2.40 (1.23)	1.68 (1.00)	2.05 (1.17)	2.28 (1.13)
Brunei Studies	2.33 (1.09)	1.95 (1.05)	2.14 (0.94)	2.00 (0.93)
Business & Economics	2.25 (1.20)	1.94 (1.17)	1.95 (1.09)	2.17 (1.13)
Sciences	2.68 (1.23)	1.79 (1.02)	1.72 (1.06)	1.93 (1.10)
Health Sciences	2.83 (1.28)	1.48 (0.85)	1.62 (0.96)	1.78 (1.08)
Integrated Technologies	2.23 (1.16)	1.53 (0.85)	1.34 (0.61)	1.56 (0.87)
Lifelong Learning	2.60 (1.35)	1.40 (0.82)	1.65 (1.18)	2.42 (1.12)
Education	2.64 (1.35)	1.74 (1.05)	1.78 (1.10)	2.12 (1.22)
p[b]	0.011*	0.058	< 0.001*	< 0.001*

NB: [a]Higher the score, more frequent; [b]Kruskal–Wallis test; *statistically significant ($p < 0.05$); PPT: PowerPoint

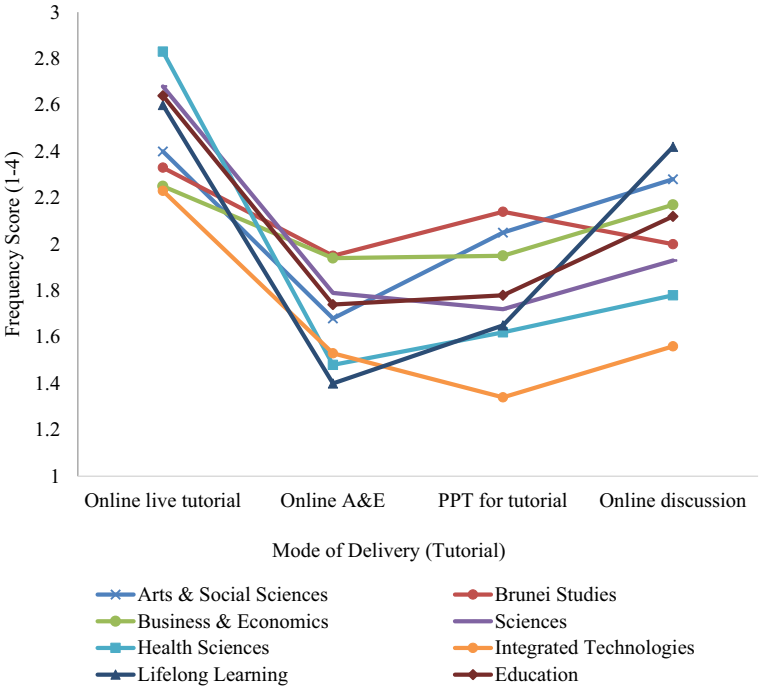

Fig. 4 Comparison of faculties on the modes of delivery of tutorials

Table 5 The effect of students' perception on online instructional delivery and modes of delivery on academic performance

Factor	SLR[a]		MLR[b]	
	β (95% CI)	p value	β (95% CI)	p value
Perception				
Very poor/Poor[c]	–	–	–	–
Adequate	0.21 (−0.22, 0.63)	0.343	0.05 (−0.38, 0.49)	0.812
Good	0.52 (0.10, 0.95)	0.016*	0.28 (−0.17, 0.72)	0.223
Very good	0.68 (0.13, 1.22)	0.015*	0.59 (0.02, 1.17)	0.043*
Lecture				
Online live lecture[d]	0.08 (−0.26, 0.42)	0.655	–	–
Recorded video lecture[d]	−0.34 (−0.58, −0.09)	0.007*	−0.31 (−0.57, −0.05)	0.019*
PPT with audio lecture[d]	0.26 (0.01, 0.51)	0.040*	0.37 (0.11, 0.63)	0.006*
Online discussion forum[d]	−0.05 (−0.30, 0.20)	0.687	–	–
Tutorial				
Online live tutorial[d]	−0.11 (−0.38, 0.16)	0.514	–	–
Online A&E[d]	−0.25 (−0.50, 0.01)	0.057	–	–
PPT for tutorial[d]	−0.07 (−0.33, 0.18)	0.583	–	–
Online discussion forum[d]	0.31 (0.56, 0.06)	0.017*	0.38 (0.64, 0.13)	0.003*

[a]SLR = Simple Linear Regression (outcome = $GPA^{1.5}$); [b]MLR = Multiple Linear Regression (outcome = $GPA^{1.5}$); [c]reference level; [d]least frequent as reference versus other frequencies

significantly related to academic performance ($\beta = 0.37$, $p = 0.006$). Contrarily, experiencing recorded video lectures was negatively and significantly associated with academic performance ($\beta = -0.31$, $p = 0.019$). However, online discussion forums did not significantly affect academic performance ($\beta = -0.05$, $p = 0.687$). Finally, experiencing tutorials in the form of online discussion forums was positively and significantly associated with academic performance ($\beta = 0.38$, $p = 0.003$). In contrast, experiencing online live tutorials ($\beta = -0.11$, $p = 0.514$), online assignments and exercises ($\beta = -0.25$, $p = 0.057$), and PowerPoint tutorials ($\beta = -0.07$, $p = 0.583$) did not significantly affect academic performance. The residuals of the SLR and MLR models were normally distributed, and there was no evidence of non-constant variance. The results show that a strong positive perception of online delivery modes of lectures and tutorials, using PowerPoints with audios, and engaging students in online discussion forum tutorials were positively associated with students' academic performance.

Discussion

The results of this study highlight the relevance of some learning environments such as synchronous and asynchronous teaching and learning delivery modes during the COVID-19 pandemic. Most of the students reported that online live lectures, online discussion forums, and recorded PowerPoints with audio were the prevalent modes of teaching and learning deliveries during COVID-19, which aligns with the literature (Azlan et al., 2020; Elkhatat & Al-Muhtaseb, 2021; Hysaj & Haman, 2020; Magalhães et al., 2020). This is

expected because these delivery methods are convenient for emergency remote teaching and learning. They provide the opportunity to combine online and in-person meetings and allow instructors to upload instructional materials for students. These delivery modes encourage interactions among students, students and lecturers, and between students and the content, which improve students' understanding, engagement, and reflections (Hodges et al., 2020; Kolb, 1984; Sellnow-Richmond et al., 2020).

Furthermore, the results show variations in the use of instructional delivery modes across different faculties. Online live lectures were mostly used in the Health Sciences and Education faculties, while recorded videos and PowerPoints were mainly used in Brunei Studies and Business & Economics faculties. Faculties related to Education and Lifelong Learning mostly used online discussions. For tutorials, the Health Sciences, Education, and Lifelong Learning faculties prevalently used live online tutorials. However, Brunei Studies and Business & Economics faculties mostly resorted to online assignments and exercises. These faculties also used PowerPoints for tutorials. Faculties related to Arts and Social Sciences used more online discussions compared with online tutorials. Meanwhile, Integrated Technologies used the least online live tutorials, PowerPoint, and online discussions for their tutorials among all faculties.

We acknowledge that the COVID-19 pandemic compelled institutions to develop and use alternative ways to support student learning. Our results highlight some disparities in instructional delivery modes. For example, the Health Sciences faculty is expected to use more online live lectures and tutorials. This is because its instructional content could require that students are exposed to live interactions, including videos on practical health sciences related issues. As this study has found, the Health Sciences faculty did not engage students mainly in online discussion compared with Arts & Social Sciences and Education faculties. These results highlight differences in teaching and tutorial delivery methods between faculties, which we did not expect. Regardless of COVID-19, students should undergo similar teaching and learning experiences. However, it appears that the online pedagogical contexts during COVID-19 have resulted in differences in how teaching, learning, and tutorials were delivered across faculties, which need to be addressed in crisis situations.

Despite the variations in the instructional delivery modes across faculties, most students were satisfied and reported positive perceptions about online learning environments. These results partially agree with the literature that argues students prefer live video and audio lectures in emergency remote teaching and learning (Callo & Yazon, 2020; Muthuprasad et al., 2021; Rapanta et al., 2020; Yough et al., 2023; Zhou & Hawrot, 2023). These instructional delivery methods provide students with the flexibility to access instructional materials to learn (Abisado et al., 2020; Azlan et al., 2020), which can improve their satisfaction and positive perceptions (Hysaj & Hamam, 2020; Lapitan et al., 2021).

In asynchronous learning, for example, students can learn instructional materials before engaging in synchronous class sections. This gives them the opportunity to ask further questions and clarify their doubts about what they have learned. Therefore, our results do not align with existing studies that argue that students are generally dissatisfied with remote teaching and learning because of a lack of motivation and interest (Amir et al., 2020; Stevanovic et al., 2021; Yekefallah et al., 2021). However, we agree that students can be dissatisfied and less interested in online instructions for many reasons that are beyond this study. The literature confirms that factors such as limited access to laptops or desktop computers, unstable internet connection, and academic dishonesty are detrimental to online learning environments during COVID-19 (Shahrill et al., 2021; Cleofas & Rocha, 2021;

Elsalem et al., 2021; Obeidat et al., 2020). These factors can limit students' engagement, which can affect their satisfaction levels and academic performance.

This study also found that certain online pedagogical delivery modes were positively associated with higher academic performance. For example, using PowerPoint with audios and engaging students in online discussion forum tutorials are positively associated with academic performance. These findings align with previous studies that reported that online learning is associated with students' achievement and engagement (Anthony et al., 2022; Elkhatat & Al-Muhtaseb, 2021; Eurboonyanun et al., 2021; Refae et al., 2021; Thai et al., 2017). This suggests that during crises such as COVID-19, prioritising online learning environments that promote the use of multiple instructional deliveries and flexibility can improve students' performance and perception of remote teaching and learning.

The results that established a positive association between PowerPoint with audios and discussion forum tutorials and academic performance are most intriguing. This implies that engaging students in online live lectures without recorded PowerPoint with audio and planned online discussion tutorials might improve academic performance in crisis situations such as COVID-19. This strengthens the hypothesis that, all other things being equal, using live video lectures without proper documentation of learning content, might adversely affect students' performance. The results of the current study refute existing research that linked live video lectures and tutorials with higher academic performance (Alzahrani, 2022; Thai et al., 2017).

A possible explanation for these results is that PowerPoint with audio that explains the main points can be useful in improving student understanding and academic performance. In online video lectures, students might not have the opportunity to re-access lessons, especially when the lessons are not recorded. Alternatively, PowerPoint with audio, when accessed by students, can help them to master instructional materials at their own convenience and pace. Therefore, instructional delivery in crisis situations such as COVID-19 should combine both asynchronous and synchronous instructions to facilitate student–teacher online communication and interactions, as well as documentation of pedagogical resources and activities.

Conclusion

This study described the mode of online delivery of lectures and tutorials during the COVID-19 pandemic. It explored the differences in the mode of delivery of lectures and tutorials across faculties. It also investigated the effect of the mode of delivery and students' perceptions of these modes on academic performance. The results showed that online live lectures and tutorials were the common teaching and learning delivery modes during COVID-19. There were differences in how online lectures and tutorials were used based on faculties. Health Sciences and Education faculties mostly used online live lectures. Recorded videos and PowerPoints were mostly used in Brunei Studies and Business & Economics faculties, while online discussions were prevalent in Education and Lifelong Learning faculties. Live tutorials were mostly used in Health Sciences, Education, and Lifelong Learning faculties, while online assignments, exercises, and PowerPoint for tutorials were prevalent in Brunei Studies and Business & Economics faculties. However, faculties such as Arts & Social Sciences, Education, Business & Economics, and Lifelong Learning mostly resorted to online discussions. Experiencing PowerPoint with audio and engaging students in online discussion forum tutorials were found to be positively and

significantly associated with academic performance compared with other means of lecture and tutorial deliveries.

To the best of our knowledge, this study is the first in Brunei and among the few in South-Eastern Asian contexts that provide an initial understanding of new technology-based online learning environments in higher education settings during COVID-19. It offers an empirical account of the faculty- and discipline-based pattern of online pedagogical contexts, students' perceptions of these contexts, and how students' academic performance has been influenced by these contexts during COVID-19. The study serves as reference material that can guide policy formulation on how remote teaching and learning can be conducted to meet the needs of students in emergency situations such as COVID-19.

The results of this study imply that there should be multiple online instructional delivery methods regardless of faculties during emergencies. For example, complementing live video lectures with other delivery methods, such as recorded PowerPoint and audio, can improve students' learning. In addition, a positive perception of online learning environments is a necessary condition for students' engagement and academic performance. This suggests that stakeholders in higher education (e.g., university management, teachers, students, and parents) should continuously explore ways to develop and sustain students' interests in online educational delivery. This includes strengthening the creation of an enabling environment that improves online teaching and learning in crises. When instructors and students access online teaching and learning tools and receive the required training, they are more likely to engage in meaningful teaching and learning experiences. This can strengthen students' positive perception, motivation, and interest in online pedagogies, which can improve their academic performance.

Online teaching, learning and tutorial delivery methods that encourage discussion among students are also important. Notably, instructional dialogues elicit students' thinking and creative abilities about instructional concepts. Providing the opportunity for students to offer constructive criticisms of the work of their peers can reveal how they understand learning content. Therefore, opportunities for students to engage in fruitful discussions about instructional concepts could contribute to their academic performance. However, these online discussions should be carefully planned, moderated by instructors, and complemented by other instructional delivery methods such as live online tutorials. Finally, pedagogical flexibility during crisis situations such as COVID-19 can be considered by university management. This can improve students' perception and academic performance when they are engaged in online learning environments.

There are several variables that could have influenced students' perceptions and performance during online pedagogies. However, we could not consider them in this single study. For example, we could not explore how instructors used instructional delivery modes in their pedagogies. Also, students could experience different or mixed modes of teaching and learning. Training in online teaching and learning for students and instructors, and the quality of teaching and learning delivery, were also not considered. Despite these limitations, this study provides an initial understanding of the instructional delivery modes for lectures and tutorials used in higher education and how such delivery modes are associated with students' perceptions and performance across different faculties. Based on the scope of this study, future studies could take up these gaps and investigate further. Given that crisis situations such as COVID-19 might require all educational contexts to implement remote teaching and learning, an empirical account of online teaching and learning during COVID-19 might be necessary for future educational planning. Therefore, future studies could consider replicating this study in other educational contexts through mixed-method

approaches. This can complement our results to inform the effective implementation of online learning environments during emergency situations such as COVID-19.

Author contributions Except for EL and DA, all other authors (MS, LN, MIP, JHS and ABZAZ) contributed to the study's conception and design. EL, DA and LN analysed the data. MS, EL, DA, LN, MIP, JHS and ABZAZ contributed equally to the first draft of the manuscript, and all authors (MS, EL, DA, LN, MIP, JHS and ABZAZ) commented on and edited the subsequent versions. All authors (MS, EL, DA, LN, MIP, JHS and ABZAZ) read and approved the final manuscript.

Declarations

Conflict of interest The authors declare that they have no competing interests.

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