Civil Engineering Student Performance Observation During COVID-19 Pandemic Period

Article history
Received
15 March 2022
Received in revised form
20 June 2022
Accepted
20 June 2022
Published online
30 June 2022

Yeong Huei Lee[a*], Kerri Bland[b], Wai Wah Low[a], Shi Yee Wong[c]
[a]Department of Civil and Construction Engineering, Curtin University Malaysia, CDT250, 98009 Miri, Sarawak Malaysia.
[b]School of Civil and Mechanical Engineering, Curtin University, Kent Street, Bentley, WA, 6102, Australia.
[c]School of Built Environment, University of Technology Sarawak, Persiaraan Brooke, 96000 Sibu, Sarawak, Malaysia.
**yhlee@civil.my, yeong.huei@curtin.edu.my*

Abstract
The coronavirus disease 2019 (COVID-19) pandemic shifted the learning method from conventional face-to-face to online. Such abrupt changes provide insufficient time for students to adapt and hence affect their academic performance. Situation seems to be critical towards engineering education, as it at most applicable to blended learning mode, with limited application of fully online mode. The objectives of this study are to compare students' academic performance with different delivery methods and identify potential learning-related issues in civil engineering material subject during the COVID-19 pandemic period. Three batches of students in the academic year of 2019, 2020 and 2021, are the targeted population, with the delivery modes of conventional face-to-face mode, mixed mode and fully online mode respectively. All three batches of students were undergoing similar assessments of a fundamental subject, Civil Engineering Materials, in Curtin University Malaysia. The findings revealed that students with fully online mode were not performing well in their assessments, notably final examination. There seems to have a lack of peer assistance and non-adaptability in the online mode. Recommendations such as effective online model and collaborative activities have been included to cope for studies during the pandemic. As it is unpredictable for the evolvement of COVID-19 pandemic, this study suggests future research to look into ways of strengthening online teaching tools in engineering degree programmes.

Keywords: student behaviour, performance, civil engineering, COVID-19, online learning.

Introduction

The conventional course delivery of world higher education changed from conventional face-to-face to online learning during the COVID-19 pandemic in order to keep education system running without delay. This forces current university students to adapt online learning without considering the readiness of students and technologies. Engineering education has been designed as content-centred, design-oriented and hands-on to develop students' critical thinking and problem solving (Bourne et al., 2005). Previous learning methods have been proven effective in engineering education, such as active learning (Lima et al., 2017), project-based learning (Mills and Treagust, 2003), blended learning (Kashefi et al., 2012), flipped classroom (Bishop and Verleger, 2013), and etc.

During COVID-19 pandemic, online learning was positively impacting the tertiary education, such as medical and dental courses in Pakistan (Mukhtar et al., 2020) and engineering course in United State of America (Asgari et al., 2021). The adaptability to the limitations of online learning seems to imply that online learning could benefit those students who performed well in face-to-face mode but disadvantage the low-achievers, with higher dropout rate in the fundamental subjects (García-Alberti et al., 2021). Some guidelines have been proposed for quality teaching and online engineering course evaluation (Khan and Abid, 2021).

There were some identified negative issues of online engineering education learning during the pandemic, such as cyber security problems, low level of students' focus, connectivity issues, lack of hands-on training, and etc (Asgari et al., 2021). In response to the emergent change of delivery mode in higher education and its impact on engineering degree programmes, researchers explored on the new and existing methods to improve engineering degree programmes. Examples include: Luburić et al. (2021) explored the success of full online teaching implementation in three software engineering subjects; Sweidan et al. (2021) tested the applicability of Student Interactive Assistant Android Application with Chatbot (SIAAA-C) in various disciplines including engineering discipline; Singhal et al. (2020) proposed a digital-based iterative and evidence-based active learning in two subjects of computer science and engineering programmes. However, to the best of researchers' knowledge, existing studies on civil engineering degree

programme during the pandemic period has not captured much attention. This study specifically observes civil engineering student performance on a fundamental subject during the pandemic period. The recorded results from the assessments are compared among three consecutive years (i.e. 2019, 2020 and 2021) which represent different students' learning experience (i.e. conventional face-to-face, mixed, and fully online).

Theoretical background

Online education theories

Based on the concept of presences: teaching, cognitive and social, Garrison, Anderson and Archer (2000) developed a "community of inquiry" model for online learning, particularly emphasizing students-instructor interaction in an active learning environment. Changing from traditional individual learning to crowd activities with internet technology, connectivism learning model is developed (Siemens, 2004). Derive from social constructivism, online collaborative learning describes the collaborative learning and knowledge building with the use of internet (Harasim, 2012).

Integrated model

Bosch (2016) developed model of blending with pedagogical purpose where the approaches are driven by pedagogical objectives and activities. The learning module contains six basic pedagogical goals: content, social/emotional, dialectic/questioning, evaluation, collaboration and reflection. This forms an integrated community of learning with active interaction.

Subject and student descriptions

Subject details

The observation was conducted for the subject of Civil Engineering Materials (CEM), which is one the core subjects in Civil Engineering curriculum. There are four learning outcomes on successful completion of this subject: able to identify the material qualities to obtain adequate performance over structures life, understand the internal response of construction materials towards external applied loads, able to evaluate material performance with the calculated internal stresses, and able to design (specify, modify or protect) with the civil engineering materials to gain better performance. This subject is delivered with two hours of lecture and tutorial respectively per week over 12 weeks period and contained three assessments, namely, laboratory reports, calculation assignment and final examination. Students need to obtain an overall of 50% and at least 45% in the final examination for passing this subject.

Targeted students

Three batches of students in year 2019, 2020 and 2021 are included in this observation. Table 1 provides a summary of these students. All of the students were in their second year of study to explore the core subjects of civil engineering degree, after completing the first-year engineering common subjects. These students experienced different learning and teaching methods, which changed mostly due to the Covid-19 pandemic. Students for year 2019 experienced face-to-face physical classes, while students for year 2020 and 2021 experienced online classes. The 2020 and 2021 batches students were differed in their first year of learning curve, as 2020 batch students experienced face-to-face and batch of 2021 experienced fully online. Therefore, 2019 batch described as fully face-to-face, 2021 batch as fully online and 2020 batch as the transition from face-to-face to online, during their two-year university life.

Table 1. Targeted students in this study

	2019	2020	2021
Total enrolled students	59	64	31
New students	56	53	25
Repeat students	3	11	6

Delivery method

The outbreak of Covid-19 caused lockdown to many countries for curbing the spread of virus in community. In response to the instruction from the government, higher education institutions are forced to close. Such closure affects the teaching delivery mode in many countries. In Malaysia, the Ministry of Higher Education Malaysia instructed all universities to opt for online teaching and learning for accommodating continuous learning.

The students in 2019 cohort experienced both first year (2018) and second year (2019) with conventional face-to-face delivery method. As CEM is the second year subject, the 2019 students represented the conventional physical class delivery method, with two hours of weekly lecture and tutorial respectively. The learning materials were obtained from learning management tool, and students could refer to the recorded lecture class from main campus in Australia, which are the similar contents for other campuses.

The 2020 cohort experienced face-to-face physical classes in 2019 (first year) and first three weeks in 2020 (second year) before lockdown occurred in Malaysia. They were in the transition period of shifting from conventional physical classes to online delivery. Some consideration steps have been applied to help these students, such as longer final examination time with 24-hour window for students to enter the final examination, and consideration for assessment extension.

The 2021 cohort experienced similar course content delivery in 2020 for their first year of study. The students met in virtual classes with their course lecturers and did all assessments through learning management tool. Overall, as shown in Tables 2 and 3, the attendance rate of live classes was not high if compared to physical classes, as students could refer to the recorded videos.

Resources access

There were several resources for the learning materials, through learning management system or cloud storage. The 2019 cohort attended physical lecture and tutorial classes with all resources provided in the learning management tool. For 2020 and 2021 cohorts, cloud storage link was provided to students for live classes recordings with additional examples. The view counted for watching these videos were recorded in Tables 2 and 3 for cohort 2020 and 2021 respectively.

Table 2. Attendance and view counted for recorded video for 2020 cohort

Date	Live attendance for tutorials, %	View counted for recorded version
Week 1	Face to face (F2F)	Not applicable
Week 2	Face to face (F2F)	Not applicable
Week 3	Face to face (F2F)	Not applicable
Week 4	29.69	0
Week 5		
Week 6a		
Week 6b		
Week 7a	26.56	2
Week 7b		
Week 8		
Week 9		
Week 10	31.25	0
Week 11		
Revision		

Table 3. Attendance and view counted for recorded video for 2021 cohort

Date	Live attendance, % Lectures + tutorials	View counted for recorded version	View counted for lecture note
Week 1	90.32	173	Not applicable
Week 2	74.19	192	
Week 3	70.96	188	
Week 4	80.65	134	
Week 5	74.19	139	8
Week 6a	45.16	102	25
Week 6b	67.74	110	
Week 7a	35.48	66	32
Week 7b	48.39	49	
Week 8	64.52	112	35
Week 9	51.61	8	19
Week 10	41.94	6	40
Week 11	41.94	8	40
Revision	45.16	8	116

Assessments

This subject contained three assessments: laboratory report (30%), assignment (20%) and final examination (50%). The assignment consisted of seven questions, where Q1, 2 and 3 with 6 marks, Q4 and 5 with 4 marks, Q6 with 7 marks, and Q7 with 3 marks (refer to Table 4). All of the marks were then converted into 20% as the final assessment marks. Five laboratory sessions were divided into six submissions, which contributing to 30% of the final assessment marks (refer to Table 5). Both laboratory report and assignment were assessed through learning management tool, and final examination was assessed through learning management tool for 2020 and 2021 cohorts, while face-to-face for 2019 cohort. All marks are shown in Tables 4, 5 and 6.

Table 4. Marks division and scores for assignment

	Q1,2,3 (6 marks)	Q4,5 (4 marks)	Q6 (7 marks)	Q7 (3 marks)	Overall*, 20 marks
2019	-	-	-	-	11.01
2020	3.538	2.497	4.469	2.120	1.262
2021	3.281	2.229	2.946	1.620	1.008
This assignment is divided into 4 sections with (total marks) each *Mark contribution of this assignment is 20%					

Table 5. Marks division and scores for laboratory reports

	1	2A	2B&C	2	3	4&5	Overall*, 30 marks
2019	32.18	67.45	42.97	59.83	45.48	28.92	20.23
2020	28.63	77.60	51.84	71.24	40.33	31.61	21.45
2021	31.06	79.06	48.49	68.26	45.94	36.23	22.24
This laboratory report assessment is divided into 6 sections *Mark contribution of this assignment is 30%							

Table 6. Marks division and scores for final examination

	Stresses				Materials	Overall*	Average time spent, min	Time limitation
	Q1	Q2	Q3	Q4				
2019	9.22	8.33	9.80	10.24	10.07	43.03	120	2 hours + 10 min reading time
2020	14.83	7.34	12.07	6.85	9.90	51.00	222	2.5 hours + 1.5 hours SU time
2021	8.44	3.16	10.23	3.94	10.65	36.42	143	2 hours + 30 min SU time
SU – scan and upload This final examination is divided into 2 sections (stresses and materials) *Mark contribution of this assignment is 50%								

Methods

Student behaviour observation

The observation included delivery, resources access and assessments. The student performances were compared with assessment records observation for three cohorts of students with different background of learning experiences (conventional face-to-face, mixed and fully online). The governing factors were analyzed and discussed.

Qualitative data collection

Student behaviour was discussed among instructors during the Board of Examination with other campuses. The comments and feedback from instructors were recorded for continuous quality improvement plan. The feedback consisted of effectiveness of content delivery, assessment, content framework and reliability of online assessment.

Analysis and discussion

After the observation, the student behaviour throughout the semester were discussed and finalized during the Board of Examination meeting. The discussion was mainly focusing on student behaviour, as others were identified as non-critical or constant throughout the study. The constant parameters are assessment type, content framework and study period.

Delivery method and student behaviour

According to the six basic pedagogical goals of integrated online model (Bosch, 2016), there is a lack of collaborative goal in the implementation of CEM online course. Due to the sudden lockdown, instructors were lack of training with regards to the online delivery. This reduced the effectiveness of the content delivery through online platform.

Students were found not interested and not constructive in learning the contents. Constructivism concentrates on the experienced dynamic structure in a learning process (Mahoney and Granvold, 2005) and online learning students did not possessed this characteristic throughout the observation. Students also seem lack of self-determination (Chen and Jang, 2010).

Assessment and content framework

In order to maintain the quality and consistency of the course, CEM has the same assessments and content framework throughout these three cohorts. The marks division, types of assessments, and topics covered remained the same. Although the assessment of laboratory was through online platform, there is a difference for students in between online/mixed delivery and face-to-face delivery. Students of online and mixed delivery methods were given pre-recorded demonstration videos and pre-determined data, and completed the online assessment through learning management tool. Students who experienced face-to-face delivery conducted the laboratory tests before attempting the online assessment.

Reliability of online assessment

By benchmarking with cohort 2019, higher passing rate was found in cohort 2020. Due to the transition period, more time was allocated for final examination and students were allowed to attempt examination in

24-hour time frame. Students may start their attempt anytime in the stated 24-hour window. Once started, students needed to complete the examination within four hours, where it has been recorded the average time spent in completing the examination was 222 minutes, which is almost four hours. It is assumed that the students were fully utilizing the time allocated for scanning and uploading to attempt exam questions, thus cohort 2020 student seems to have more time in completing the exam.

In order to solve the arising issues such as academic misconduct and prolonged scanning and uploading time, the final examination in 2021 has been modified to online invigilated exam with shorter time allocated for scanning and uploading, as well as eliminate 24-hour activation window. Therefore, all of the students must attempt the questions at the same time. However, this examination has recorded lower passing rate compared to benchmark. As the 2021 cohorts only spent the first three weeks of their university life in campus, group study or peer assistance seems not non-accessible to the students, but could only through instructors' consultation for problem solving.

Information seeking is one of the major focuses in engineering first year study (Lamont, 2020). The online learning mode since in the first year of study has hauled the students from pedagogical to andragogical or even heutagogical learning, from high school to tertiary education. Despite the additional examples which not being provided to other cohorts who experienced face-to-face delivery, the students experienced online delivery scored unsatisfactory results in the final examination.

Critical discussion

Student performance in CEM was compared for three cohorts which representing students who experienced conventional fully face-to-face mode (year 2019), mixed mode (year 2020) and fully online mode (year 2021). The highest passing rate was reflected in cohort 2020 and the lowest in cohort 2021, as shown in Table 7. Majority of the students fall under the range of 50%-60%, skewed towards the right for normalized graph. As CEM is one of the core subjects in civil engineering curriculum, the students might find it more difficult as compared to the first year subjects. From the assessments, students performed almost equally balance for both assignment and laboratory report. Therefore, the analysis is concentrated on the final examination, as it is the passing requirement for this subject.

Subjects in first year engineering study with general mathematical principles are easily caught up with reference books. However, it might become challenging when stepping into core subjects of civil engineering curriculum in the second year of study. The stress analysis in this subject may require deeper understanding of internal responses of a structural members and material behavior. The information seeking behavior should be developed in the first year of engineering study (Lamont, 2020). The passive learning style of students shall be transformed for better performance. Throughout this transformation, educators play an essential role in enhancing students' learning interests. With both learners and educators efforts, better performance can be achieved to produce more competitive engineers in the future.

Table 7. Overall marks distribution with passing rate

	Passing rate, %	Marks					
		90-100	80-90	70-80	60-70	50-60	Fail
2019	71.19	0	0	7	9	26	17
2020	81.25	2	4	9	17	20	12
2021	38.71	0	2	3	4	3	19

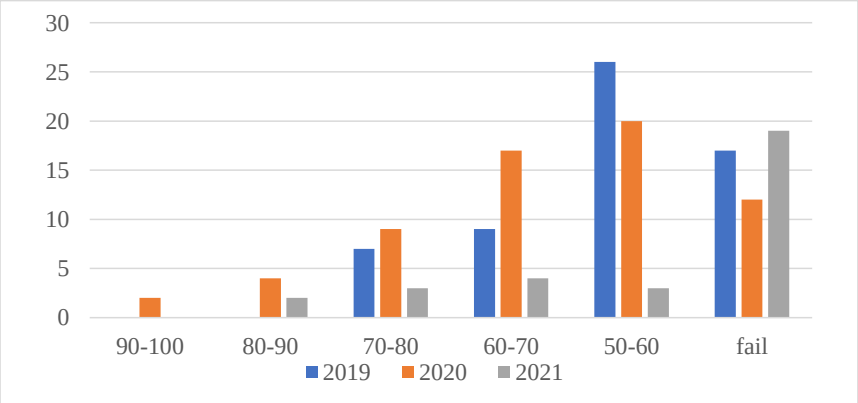

Figure 1: Mark ranges for cohorts 2019, 2020 and 2021

Effective online model should be setup in accordance to the integrated model (Bosch, 2016), as it identified the lack of collaborative element in online delivery. Learners need to develop their interests to make the process towards constructivism with high self-determination. Moreover, according Ko and Rossen (2017), an extra course should be delivered by the institution in preparing students for online courses. Online course framework is suggested by Reeves et al. (2018) to consist of components related to course overview, communication, activities for collaboration and interaction, content presentation, and assessment.

According to How People Learn (HPL) theory, the interaction between learners, knowledge, assessment and community should be considered in the learning process (Kuchi et al., 2003). In order to develop the effective online course, HPL should be incorporated into course's framework, which seems to be lack of consideration in the pandemic period.

Conclusions

The COVID-19 proposed social distancing which prompted fully online as the sole teaching and learning mode for education system. However, the fully online mode is challenging for engineering education due to the limitations of course design. In this study, observation was conducted for three batches of civil engineering students, by comparing their assessments' results. Several conclusions were drawn.

i. Lower average mark was obtained for fully online mode students when benchmarking against conventional face-to-face mode students.
ii. Relatively higher mark was obtained for mixed mode students (i.e. mixed classes of online and face-to-face) as longer time was allowed for final examination.
iii. The low scoring marks in assessments for students experiencing fully online mode, could be affected by students' incorrect information seeking behavior, and limited peer assistance due to a lack of involvement in campus life.
iv. Educators should assist students' learning interests with collaborative activities for overcoming students' passive learning.

This study urges the educators in civil engineering field to improve the existing learning and teaching methods in the fully online learning and teaching virtual environment. This is crucial in maintaining and strengthening the employability of civil engineering graduates during and after the COVID-19 pandemic.

Acknowledgement

The authors would like to acknowledge the supports provided by Curtin University.

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