

# Teaching Software Engineering Virtually during COVID-19 Pandemic Era: Lessons Learned

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## Abstract

The COVID-19 pandemic has hit the world since December 2019 and it had been serious in Malaysia in middle of March 2020. In Malaysia, the Movement Control Order (MCO) has forced many sectors to cease operation except those in essentials sectors. The pandemic has transformed many sectors including tertiary education dramatically mainly in its digital applications. Although face-to-face teaching and learning has been the bread and butter for most of tertiary higher learning institutions, the pandemic has forced 360-degree change in the way teaching and learning materials to be delivered. This includes the transformation in assessment methods that forced lecturers to find the best alternative in assessing their students. This paper reports the lessons learned in teaching Software Engineering course that has been transformed to 100 percent online teaching and learning (OLTnL) during COVID-19 pandemic in Malaysia between March to June 2021. The subjects were second year students of two sections of 44 and 37 respectively who enrolled Software Engineering course as one of the core courses at the selected faculty offering a Bachelor of Computer Science program. The findings reflect that the students who are majoring in Computer Science still face challenges in OLTnL even though they have been in the third semester of virtual lectures since March 2020 due to the COVID-19 pandemic. Some insights from the lessons learned could be considered if OLTnL continues.

## Keywords

COVID-19 pandemic, online teaching and learning, virtual lectures, software engineering course, tertiary education

## 1. Introduction

Online teaching and learning (OLTnL) have been a mandatory when students around the world face the restrictions due to COVID-19 pandemic since early 2020. Many sectors have been closed but slowly reopened and reclosed based on countries. As for the education sector, it must move on despite the challenges. In Malaysia, all levels of education, from primary to tertiary were conducted fully online in 2020 and slowly reopened nationwide in 2021 for primary and secondary levels. Due to the increase of cases, both primary and secondary schools had moved

back to OLTnL while the tertiary education continued to be online.

This means majority of students in the tertiary level in Malaysia have been studying online since March 2020 and is expected to be back to campus in stages starting mid-October 2021 when the Malaysian Government is expected to declare COVID-19 as endemic based on the nation's vaccination target. In the scope of this paper, the study involved second year students who only attended their physical lecture for their first semester in the first year and have been studying online for three semesters. They enrolled the Software Engineering course in their second semester of second year.

Proceedings of 4<sup>th</sup> Software Engineering Education Workshop (SEED 2021) co-located with APSEC 2021, 06-Dec, 2021, Taipei, Taiwan

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CEUR Workshop Proceedings (CEUR-WS.org)

Many OLTnL studies have been conducted such as that of Adera and Fisher [1] reports a study of college students completed at least one online course before graduation. It highlights best practices for online instructors through the course development and its delivery process. In addition, the study of OLTnL specifically for Software Engineering course could also consider 21st century learning and innovation competencies [2]. OLTnL in normal circumstances could be challenging to students with disabilities. Williams [3] states that instructors can be more culturally responsive when teaching students with disabilities mainly in OLTnL. While Pendergast [4] reports that almost all universities websites had accessibility errors for such students.

However, conducting OLTnL seems more challenging during the COVID-19 pandemic era to even both students and instructors or lecturers at the tertiary level. This is due to the fact they are forced to suddenly change from face-to-face (F2F) to virtual lectures under unprecedented circumstances, which cannot be compared with properly planned OLTnL offered by universities or colleges in their 100% online programs or some online courses. Recent works have reported challenges and possible solutions in OLTnL during the new normal. For instance, the study in Japan by Yamada et al. [5] reports the challenges in teaching an introductory software engineering course during the pandemic period in May 2020. It shares how the lecturers developed an environment for the students to complete their Web application development tasks. This shows that during the pandemic period, instructors or lecturers had to find alternatives to support OLTnL, which is more challenging and causes more workloads as compared to the F2F mode.

In addition, Bringula et al. [6] highlight 13 key challenges in OLTnL that involved software development project in a software engineering course taught at a university in Manila. The study concludes that the lecturers could not address the challenge in relation to the Internet connection and power supply. Hence, this paper contributes by reporting the lessons learned when conducting the Software Engineering course at a university in Malaysia that comprised diverse demographic of students, different scope of course contents and assessments as compared to some existing studies [7][8][9][10] related to OLTnL during COVID-19 pandemic era. The following sections elaborate the study (Section 2), analysis and findings (Section 3) and finally its conclusion in Section 4.

## **2. Case study**

The section includes the explanation on the selected students, course information for Software Engineering, and its assessments.

### **2.1. Selected students**

There were ten sections of second year students enrolling the Software Engineering course as the core course in four Bachelor of Computer Science programs offered in Session 2020/2021, Semester 2. In this study, two sections were selected: Section 3 of 44 students under the Bachelor of Computer Science (Network and Security) coded as SECR, and Section 6 of 37 students under Bachelor of Computer Science (Software Engineering) or SECJ. Other programs are Bachelor of Computer Science (Bioinformatics) and Bachelor of Computer Science (Graphics and Multimedia Software).

Hence, the study applied non-probability sampling method that is cluster sampling by selecting one sample group of five SECJ sections and one sample group of other specializations. For the SECJ students, they also register an elective course under SECJ that is Requirements Engineering and Software Modeling (RESM) to enable them solving the same problem for their projects. Thus, the students from Section 6 under SECJ had to be in the same teams for both courses during the semester.

### **2.2. Software Engineering course information**

The three-credit Software Engineering course is offered to second year students in their second semester that is their fourth semester of the total eight-semester study. Table 1 shows the details of modules covered by weeks and respective assessments with percentage over 100% within the total of fourteen teaching weeks.

### **2.3. Assessments**

The assessments include the individual and team based for the ratio of 55:45 as detailed below. Refer to Table 1 for the corresponding modules and teaching weeks for each assessment.

**Table 1**  
Course information

Week (W) No. / Module No.	Assessment Distribution by Module		
	Module	Assessment	%
W1/M1	Introduction to software engineering		
W2/M2	Software process model		
W3/M3	Agile software development	PS1*	3
W4/M4	Requirements engineering		
W5/M5	Requirements analysis and modelling	PR1*	6
W6/M5		PR2	7
W7/M5		ME*	25
W8/M6	Architectural design		
W9	Midterm break		
W10/M7	Object-oriented detailed design	PS2	3
W11/M7		PR3	7
W12/M8	Software verification, validation and testing	PS3	4
W13/M8			
W14/M8		PR4	5
W15/M8		SR*, PW*	5, 5
W16	Revision and exam week		
W17- W19	Exam week	FE*	30

\*PS: Problem solving, PR: Project report, ME: Midterm exam, SR: Self-reflection, PW: Peer review, FE: Final exam

Individual assessments include both mid-term and final exams that have been changed to the mid-term alternative assessment (AA) and the final AA due to OLTnL. They contribute 25% and 30% respectively for the individual assessment (see ME and FE in Table 1). While there are four different types of assessment for team-based assessments. Students should form a team of four to five members to meet this assessment as follows.

- Problem solving: Students should solve the given problems between one to two hours during the lecture hours in their team based on the selected modules of respective weeks with this type of assessment. It carries 10% of the total assessment (see also PS1, PS2, PS3 in Table 1)

- Project proposal: Students are given the problems to be solved as a software project that carries 6% of the total assessment (see PR1 in Table 1).

- System documentation (SD): There are three parts of project reports that follow a simplified and customized SD template adapted from IEEE Recommended Practice for Software Requirements Specification (SRS) (IEEE Std. 830-1998), Software Design Descriptions (SDD) (IEEE Std. 1016-1998 1), and Software Test Documentation (STD) (IEEE Std. 829-2008). The SD contributes 19% of the total assessment (see also PR2 to PR4 in Table 1). The students are only required to develop high-fidelity prototypes for the scope of this course.

- Reflection: Includes writing a short reflection essay on both leadership and teamwork experience that should also be updated gradually via an online e-portfolio as required by the university (see SR in Table 1).

- Peer review: Students evaluate their peers who are members within their respective team (see PW in Table 1).

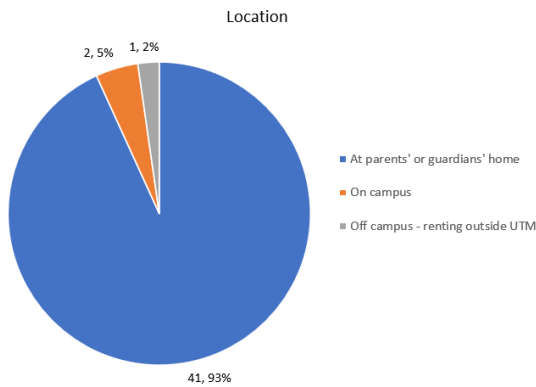
### 3. Analysis and findings

This section elaborates the analysis and findings of the survey, students' challenges, threat to validity and lessons learned from the study.

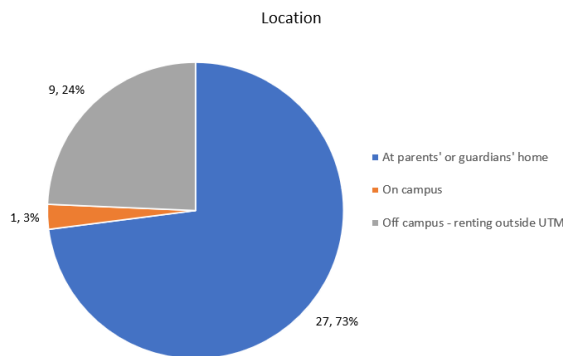
#### 3.1. Survey

The study includes demographic, learning methods, team formation, challenges in teamwork and medium of online communication. Figure 1 shows students' location for Section 3. Majority of the students (93%) were at their parents' or guardians' home while two students (5%) staying on campus and one student staying off campus (renting outside). In addition, this section consisted of only one student from Indonesia while the rest are Malaysians.

For Section 6 (see Figure 2), 27 students (73%) were at parents' or guardians' home, nine students (24%) stayed off campus, and only one student (3%) was on campus. Compared to Section 3 that comprised only one non-local student, Section 6 has more international students than local students with the ratio of 76:24. Hence, more challenges were expected among students in Section 6 due to this huge diversity.



**Figure 1:** Students' location (Section 3)



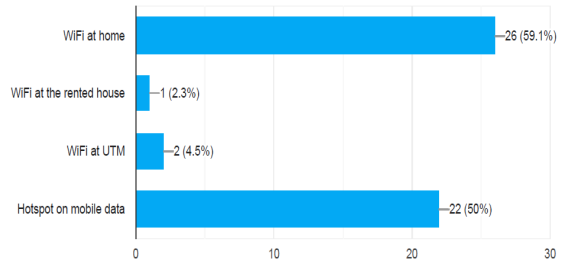
**Figure 2:** Students' location (Section 6)

Students could stay on campus during the pandemic period with certain reasons such as low Internet bandwidth and non-conducive environment at home. In this study, only three students were on campus from both sections. While students who had been renting outside the university, were mostly international students who did not return to their countries during the pandemic period due to some reasons.

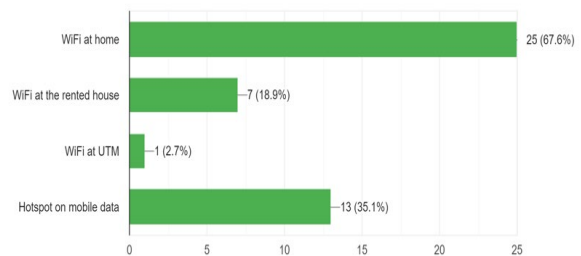
Both Figure 3 and Figure 4 show that more than 50% of students (59.1% and 67.6% respectively) had WiFi at home besides using hotspots on mobile data (50% and 35.1% respectively). Those rented outside the campus mostly had WiFi too. The analysis deduces that all students had no issue in accessing the Internet including some international students who went back to their hometowns in Saudi Arabia (five students), Indonesia (seven students), Qatar (one student), Mauritius (one student), and United Arab Emirates or UAE (one student).

However, with multiple time zones among the students, OLTnL could be challenging for some students mainly those in Section 6. For instance, Malaysia is five hours ahead of Saudi Arabia, four hours ahead of Mauritius, and one hour ahead of Indonesia. Based on lecture timetables, Section 6 was on every Sunday at 10:00 am while Section 3

was on every Monday at 8:00 am. Thus, students in Section 6 such as those in Saudi Arabia had to adapt with the time difference as they had to join the virtual lectures at 5:00 am of their country time (ahead of sunrise time at around 5:45 am).

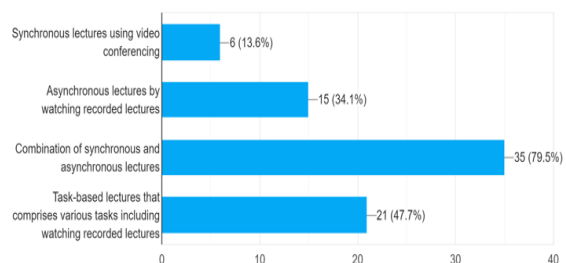


**Figure 3:** Students' Internet access (Section 3)

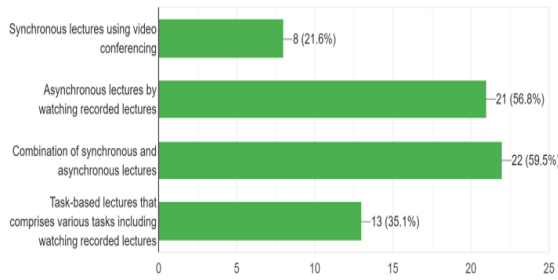


**Figure 4:** Students' Internet access (Section 6)

Regarding students' preferred OLTnL methods, most students preferred the combination of synchronous and asynchronous lectures (79.5% and 59.5% respectively) while the least preferred method was synchronous lectures using video conferencing only (13.6% and 21.6% respectively) as shown in Figure 5 and Figure 6. This is because not all of them having WiFi access at home or rented houses while some of them accessing hotspots on their mobile data. Students with a good Internet access preferred synchronous lectures using video conferencing, 6 (13.6%) and 8 (21.8%) respectively.



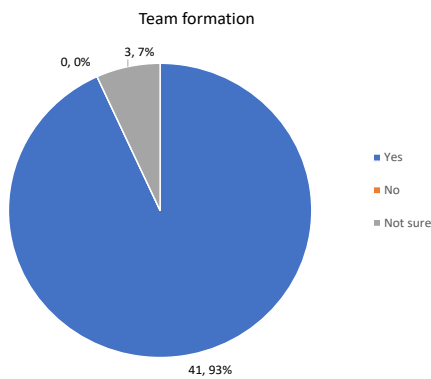
**Figure 5:** Students' preferred OLTnL methods (Section 3)



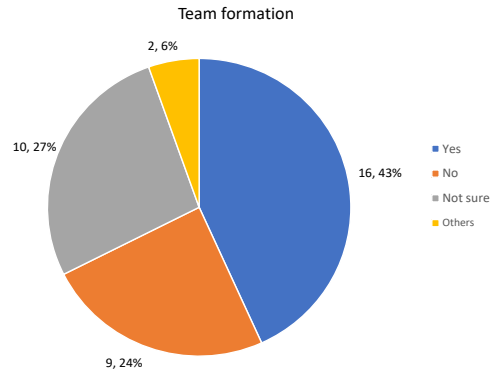
**Figure 6:** Students' preferred OLTnL methods (Section 6)

As second year students register 18 credits or six courses, they could not afford to have 100% synchronous lectures using video conferencing that might use up to 1GB data per hour. Hence, for the benefits of all students, the combination of synchronous and asynchronous lectures was applied as the OLTnL method. Asynchronous lectures require video recording that reduce interactivity in OLTnL, but it is a good alternative for students with a low Internet bandwidth.

Regarding team formation of four to five members per team, students in Section 3 were given the opportunity to form their own teams. Figure 7 shows most students (93%) stated "Yes" that they gained a lot of benefits by choosing their own team members. Only three of them (7%) were not sure whether it was beneficial to them. However, students in Section 6 (Figure 8) were distributed into teams by lecturers to meet the need of the integration with the elective course using the same problem for their projects. Only 16 (43%) stated "Yes" that they gained benefits from the assigned teams, while nine (24%) stated "No" and ten (27%) stated "Not sure". Two of them (6%) stated "Others" with the reason they could not foresee the benefits as a student.



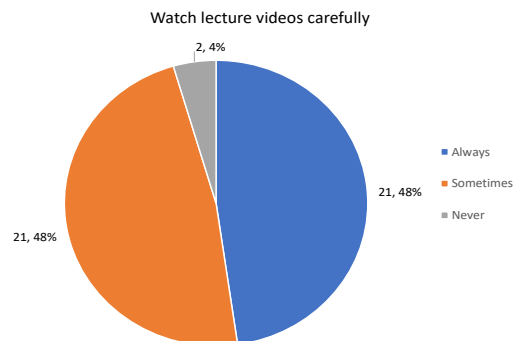
**Figure 7:** Team formation by students (Section 3)



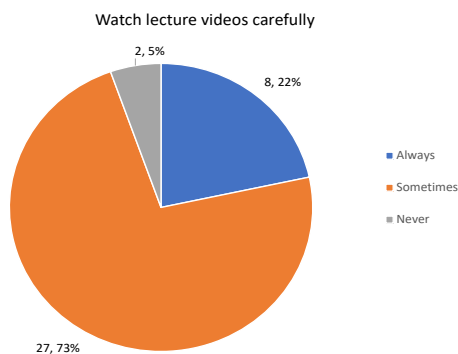
**Figure 8:** Team formation by lecturers (Section 6)

The analysis deduces that students preferred to form their own teams as they could work with their own friends who they are familiar with. This is more crucial during the pandemic period as most students were distributed and could only discuss online among team members. Students could also have diversity in their timetables. Those being assigned by lecturers in Section 6 also faced related challenges that caused low number of them (43%) stated "Yes" to the benefits of team formation by lecturers.

As analyzed earlier regarding students preferred learning methods suitable with their Internet access status, students were expected to watch lecture videos carefully that is without skipping. Figure 9 and Figure 10 show that only 21 (48%) and eight (22%) students from respective section watched the lecture videos carefully as alternative for online lectures via video conferencing platform. While 21 (48%) stated "sometimes" for Section 3 and 27 (73%) for Section 6. Two students stated "never" for both sections that is 4% and 5% respectively.



**Figure 9:** Watching lecture videos carefully by students (Section 3)



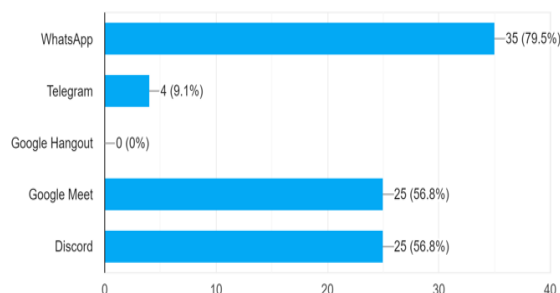
**Figure 10:** Watching lecture videos carefully by students (Section 6)

From the analysis, it deduces that most students could not pay full attention to lecture videos and preferred to skip in order to complete the given tasks during lecture hours. Short topics were compiled as 15-minute lecture videos while longer topics comprised two recordings of 15 minutes each. Students were required to view the lecture videos before referring to the slides when completing the given tasks. As lecture videos explained the gist of the topics which were not limited to what in the slides, skipping the videos had caused students not understanding the topics well. This could be seen when some tasks were given based on the explanation in the lecture videos were not answered correctly by some students. However, some students could have skipped the videos due to the low Internet bandwidth that caused them not able to watch carefully and had to rely on slides.

Compared to the Internet access in Figure 3 and Figure 4, it shows that even though more students in Section 6 had WiFi at home (67.6%) as compared to Section 3 (59.1%), students in Section 6 were less in term of “always” watching the lecture videos carefully without skipping (22%) as compared to Section 3 (48%). Thus, the findings reflect that the low Internet access might not be the major factor for them to skip when watching the lecture videos. There could be other factors that cause more students in Section 6 to place less attention when understanding the topics through the lecture videos as the alternative.

As it was a 3-credit course, the three-hour lectures per week were normally divided into a 1-hour task-based lecture where students had to watch uploaded lecture videos either one 15-min video or two files of 15-min videos for longer topics. Then, they had to answer some given questions via the e-learning upon watching the lecture videos. In the following hour, they had

team-based discussion using their own selected platforms mostly using the combination of WhatsApp, Google Meet and Discord (see Figure 11 as the example). While the balance of 40 to 50 minutes was used to give feedback along with question-and-answer session for their submitted answers or solutions to the given tasks or exercises and their team-based projects.



**Figure 11:** Applications used for team discussion (Section 3)

### 3.2. Challenges in teamwork

Appendix A shows the challenges faced by the students in both sections. The most challenging aspect for most students in Section 6 were time zone difference (61.8%) while those in Section 3 mostly faced the low Internet bandwidth to join live discussions (52.6%). This issue is related to the team formation as students were assigned by lecturers, thus one team comprised of both local and international students who some of them were at their hometowns (see also Figure 1 and Figure 2 regarding students’ locations).

In addition, students from both sections faced different timetables to set their team discussions that were 26.3% for Section 3 and 32.4% for Section 6. They also faced challenges in lack of mutual understanding among team members 26.3% and 26.5% respectively. These two factors were unexpected to be high for Section 3 that was allowed to team up by themselves. It shows that diversity of timetable among team members could be challenging in teamwork. Hence, allowing them to choose their own team members could reduce this challenge at certain level. However, being in the same team with friends for Section 3 seems to be as challenging as those who were assigned not to be with friends (Section 6) from the perspective of mutual understanding.

Other challenges include lack of commitment among teammates that was quite high for Section 6 (26.5%) as compared to Section 3 (10.5%), no

time zone issue for Section 3 as it only had one Indonesian student, while not many students in Section 6 faced the challenges with low Internet bandwidths (17.6%). Thus, it is found that team formation by lecturers could lead to other related challenges such as time zone difference and teammates commitments.

### 3.3. Threat to validity

There were a few threats in the study that include the sincerity of students when answering the questions as some students might avoid revealing their actual perspectives in some questions such as team formation and the way they watched the lecture videos. In addition, students needed to provide their emails during the online survey to ensure everyone answered the questionnaire as part of the course survey to be reported at the end of the semester. Hence, some of them might not give their actual opinions for certain questions as their emails were collected. To reduce the threat, students were reminded that their identities were not revealed in the report.

### 3.4. Lessons learned

Lessons learned when teaching the one-semester Software Engineering course during the COVID-19 pandemic era are summarized as below.

- Some international students were at their hometowns. Thus, they have time zone issues to adapt with the course timetable and team-based discussions. In this case, students should be allowed to choose their own team members to reduce this challenge.
- Although the study was conducted after a year of students experiencing OLTnL, some students still faced low Internet bandwidths and could not afford to have long hours of synchronous OLTnL. Thus, combination of both synchronous and asynchronous mode in delivering the course contents would be helpful. Students with a good Internet access had to understand the situation for fairness.
- Students need to have better self-discipline to watch the lecture videos carefully without skipping as the videos were substitutes for live lectures besides slides.
- Students faced a few challenges in teamwork that could also affect the team-based assessments in the course. Therefore, team

formation by students own choice could eliminate this issue as they could not meet their teammates physically during the pandemic era.

- A possible solution in term of team-based assessments include allow students with teamwork challenges to change their teams in earlier weeks especially in the case of students are assigned by lecturers. While students who could not commit need to be grouped together with close monitoring by the course lecturer.

In short, some issues derived in this case study could be eliminated in future based on these lessons learned should OLTnL continue due to unexpected circumstances during the pandemic era or later during the endemic phase.

## 4. Conclusion

The case study concludes that the second-year students of both sections still faced challenges in their OLTnL during the pandemic era. The selected sections represent two main group of students that were software engineering versus other Computer Science specializations. Section 3 with only one international student faced less challenges as compared to Section 6 with high diversity in students' demographic. The team formation was either by students' own choice in Section 3 or by the lecturers' assignment in Section 6. The findings deduce that the team formation by lecturers had less benefits in students' opinion and caused certain teamwork challenges such as lack of commitments among teammates. The lessons learned could provide the insights for future improvements in OLTnL during the pandemic era which is expected to be endemic very soon.

## 5. Acknowledgements

The author thanks the students of both Software Engineering course sections who participated in this study and Malaysian Software Engineering Interest Group (MySEIG) for supporting the work.

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## Appendix A: Challenges faced by both teams

