Covid-19: Effects of online teaching to student attainment in Electromagnetic course

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ABSTRACT – Covid-19 pandemic has affected almost every country in the world and able to spread via human-to-human transmission. One way to stop the virus from spreading is through movement control order (MCO). But the education activities must still go on by adopting online teaching. However, the implementation of online teaching especially to a course with an extensive mathematical derivation like Electromagnetics is challenging and might affect the student attainment. In this paper, the student attainment of Electromagnetic course that underwent online teaching was observed. As a result, it is found that online teaching could improve student understanding of the Electromagnetic course.

1. INTRODUCTION

When the Covid-19 pandemic strikes Malaysia, the Malaysian Government has imposed Movement Control Order (MCO) on all Malaysian. The MCO was imposed in several stages start from 18th March 2020. The MCO stages are including normal MCO, enhanced MCO, Conditional MCO, Targeted Enhanced MCO, and Recovery MCO that come with specific standard operating procedure (SOP).

During the first stage of the MCO, almost all normal activities like face-to-face teaching activities in all schools and institute, business activities, sports and recreation, and interstate crossing movement were banned. To avoid the situation getting worst, all Malaysians had no other choices but to give their support and cooperate with the new regulations imposed by the government. However, education activities including at the tertiary level still need to be carried out to continue producing high-quality graduates for the job market. The medium, however, has now been shifted from physical to online learning.

The same quest is shared by Universiti Teknikal Malaysia Melaka (UTeM). UTeM has always encouraged online learning activities as a supporting resource for face to face sessions. A portal named U-Learn is utilized to implement this. Furthermore, each course offered in UTeM is targeted to achieve at least 30% of blended learning. Usually, the U-Learn being used to uploading lecture notes, exercise, and performing certain student assessments like quizzes and assignments. However, to conduct 100% on-line teaching, another platform is subscribed by UTeM which are Microsoft Team (MT) and Cisco Webex. These platforms are suitable to use to conduct synchronous online teaching like live class. For asynchronous online teaching like pre-recorded video, platforms like YouTube, Screen-o-Matic, and Loom could be utilized.

One of the courses offered by UTeM to the electrical engineering undergraduate program is Electromagnetics (EM). The EM course contains fundamental knowledge of electrical engineering. It is recognized as the most difficult course among electrical engineering undergraduate students. The course is abstract and requires a strong foundation in engineering mathematics [1,2]. Most of the universities that offer this course will have similar content as discussed in [3]. Due to the complexity of this course, most educators propose Technology Enabled Active Learning to increase student enthusiasm in the EM course [4,5]. Some of them suggested using software like MATLAB [4], self-developed Interactive MATLAB-based GUI (graphical user interface) [3], Mathematica [6], and the Numerical Electromagnetics Code (free software) [1]. On the other hand, other educators suggested improving EM delivery by introducing a hardware-based experiment [7,8] and even through embedding soft skill elements [2]. However, due to the MCO, the teaching and learning activities were only able to proceed through online means with limited access to perform using the above-mentioned methods. In this paper, the effect of online teaching on the student attainment of the EM course was focused on.

2. BACKGROUND OF STUDY

Generally, the student attainment in any course is evaluated overall marks and grade. Student attainment is measured through their achievement from several assessment types such as quizzes, assignments, midterm tests, and final examinations.

On top of that, student attainment also being measured through 12 Program Outcomes (PO) as stipulated in the accreditation manual [9]. The POs cover a comprehensive range of attributes from engineering knowledge and problem-solving abilities up to soft skills like communication and entrepreneurship. For the EM course, student attainment is evaluated only based on knowledge (PO1) and problem analysis (PO2). Each assessment type is mapped to respective POs. Table 1 shows the mapping of assessment type and PO.

To complete this study, the data on internet accessibility of the student was investigate. The investigation was conducted through a survey. The survey was distributed through online to all the student that registered the EM course during semester 1 of academic session 2020/2021. As much as 154 students submit their responses. On the survey, the information

such as student locality, internet coverage in term of speed and data size were gather. On top of that, the student preferable study style also being observed.

Table 1 Matrix of assessment type and PO

Assessment	PO1	PO2
Quiz 1	2.5%	
Quiz 2		2.5%
Assignment 1	7.5%	
Assignment 2		7.5%
Midterm test (Q1)	10%	
Midterm test (Q2)		10%
Final exam (Q1)	15%	
Final exam (Q2)		15%
Final exam (Q3)		15%
Final exam (Q4)		15%
Total	35%	65%

3. RESULTS FROM STUDENT'S SURVEY AND TEACHING STYLE

When the MCO was imposed, it affected the way teaching and learning activities (TLA) were conducted. Before the decision on how the TLA should be conducted for the EM course, a survey was performed on all the registered students of the EM course. The purpose was to gauge the student's internet accessibility and quota for internet data and identify students who may need special assistance during the online learning process.

3.1 Students locality

The student's location is divided into six regions. They are the Northern region, the Central region, Southern region, East Coast and Borneo Island. UTeM is located in Melaka.

Figure 1 shows the distribution of student's locality throughout Malaysia. Many students went back to their hometown prior to lockdown. However, some of them chose to stay either in their hostel or rented homes in Melaka despite coming from other states. The distribution of student's locality based on region is depicted in Figure 1 with further classification for those who were in Melaka.

Based on the data shown in Figure 1, the student distribution almost similar to regions in Peninsular Malaysia. Only about 3.3% of the students were from the Borneo archipelago. Among the students who stayed in Melaka, most of them stayed in the residential halls on campus. The rest either stayed at their rented houses or their family homes.

3.2 Internet accessibility

Due to the TLA was conducted through online teaching, internet coverage is a main factor to ensure its effectiveness. The internet coverage was observed through two factors which are speed and data quota.

The student needs to verify their internet speed first through http://speedtest.tm.com.my/ which is a platform provided by Telekom Malaysia (TM), the main internet provider in Malaysia. The website shows the internet speed provided by any internet provider used. The student needs to put only information on the download speed. The internet speed of the student is divided into four categories which are 1 – 5 Mbps, 5 – 40 Mbps, 40 – 100 Mbps, and > 100 Mbps.

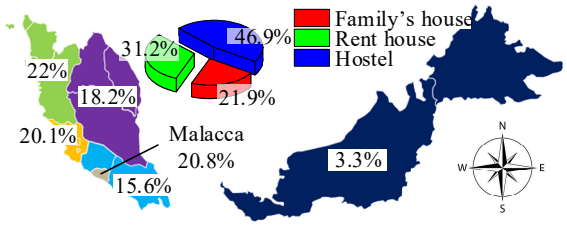

Figure 1. Distribution of students

The internet speed of the students is distributed as shown in Figure 2. Based on the data shown, only 13.6% of students having a high internet speed (>100 Mbps). It is comprised of all the students that stayed in UTeM's and several students from the Central region of Malaysia. With this speed, the students are expected to have no problems with synchronous online sessions. However, the majority of them have low internet speed (1 – 5 Mbps). This may impede their ability to actively participate in synchronous online sessions.

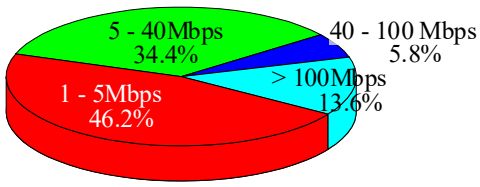

Figure 2. Internet speed of students

The effectiveness of online teaching also depends on the data quota. The larger the data quota, the more effective the online teaching. The data quota might be the difference between the internet service provider depending on the package offer. Some packages come with unlimited data quota but others might offer otherwise. Luckily, the Malaysian Government has initiated the Economic Stimulus Package during the MCO. Under this package, every registered mobile account is eligible to apply for 1GB internet data daily with no extra charges. Therefore, an additional 30 GB of data quota is available on top of the available quota each month.

The data quota is divided into 3 categories-- 1 – 20 GB, 20 – 50 GB, and > 50 GB. The data quota is based on the original internet package. The data quota > 50 GB is including the internet package that offers unlimited data. The internet data quota of the student is as shown in Figure 3. Based on Figure 3, it is shown that the majority of the student is subscribing to the > 50 GB internet data quota.

The synchronous online teaching was conducted through Microsoft Teams (MT). In general, MT consumes about 450 MB of internet data for one hour of a group video conference. Therefore, the student should have a minimum of about 5.4 GB each month. Assuming each student registers 5 courses in the semester, they need

about 22 GB each month. Theoretically, the students should have little trouble joining synchronous class sessions.

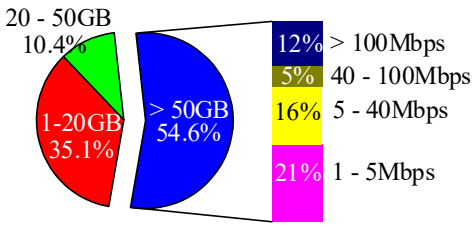

Figure 3. Internet data quota of students

However, the synchronous online session is less effective for students having slow internet speed. Figure 3 shows that even though a majority of the student is subscribing the large internet data quota, only 12% of them have good and reliable internet speeds. The student might have sufficient data quota, but due to limited internet speed, it might affect their internet connection during the live class.

3.3 Students attribute

Apart from internet coverage, the effectiveness of online teaching also depends on the student attributes and perception towards it. There are 3 aspects covered from the survey, which are the preferred studying style, the online teaching medium, and the self-perception toward online teaching. Under the preferred studying style, two factors were observed: self-study vs group study and online vs physical class.

Figure 4 shows the survey data on the preferred studying styles. About 46% of students said that they prefer the TLA to be conducted through both mediums which are online and face to face. Most of the students who chose this style prefer to study in groups rather than individually. Most of them believe that through the face-to-face teaching, the discussion can be effectively conducted while online teaching offers flexibility for them. Only about 22% of them choose to have a fully online class even if there is no lockdown with the distribution of those who prefer studying in groups or individuals are the same. They believe that most of the information can be found online and online discussion with the lecturer serves to verify their understanding and clarify ambiguous aspects of the material.

Due to the MCO imposed, the TLA had to be implemented through online teaching. There are two methods of conducting online learning under these situations, either through synchronous online teaching (i.e live classes) or through asynchronous online teaching (i.e. pre-recorded video). Based on the survey findings, about 75% of the students chose to have asynchronous sessions as the main online teaching medium. With pre-recorded videos, students can learn the materials at their own time and can easily replay parts that are of interest and skip parts that are not. It also solves the issue of intermittent connectivity that students encounter during live sessions. On the other hand, the rest of the students felt that they have no issue with internet coverage and chose synchronous learning since they can ask questions and clarify parts they do not understand directly.

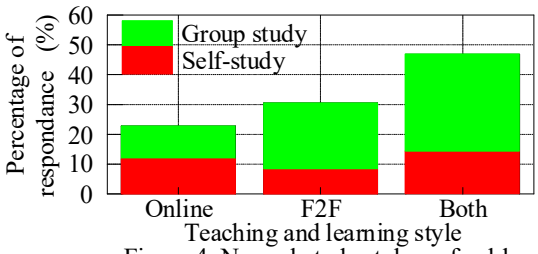

Figure 4. Normal study style preferable.

3.4 Teaching technique

By considering several factors like internet coverage and effective communication between student and lecturer, online learning was conducted using pre-recorded video (asynchronous learning) with live classes as supplementary. The pre-recorded videos will be uploaded on YouTube one week before the actual class schedule for students to view and the link is published in UTeM's U-Learn portal. This allows the students to either stream or download it with a resolution that suits their requirements. This feature solves the problem of low internet coverage while enabling flexibility in studying time.

To enhance the understanding of the student on the course content, a live class is conducted as supplementary. The live class was recorded and the link for the recorded live class was made available in UTeM's U-Learn portal. To reduce the data consumption, the slot for the three-hour lecture was divided into three, one-hour sessions. Each student was encouraged to join at least one session per week. To increase the effectiveness of the live class, each session is only open for a maximum of 20 students. The live class was dedicated only to answer questions the student may have with regards to the material but not for delivery of a full lecture.

On top of that, a cross-platform messaging and Voice over IP (VOIP) application such as WhatsApp and Telegram were also being used for communication outside the classroom. Students with limited internet coverage can fully utilized this platform for discussion. From this platform as well, several short videos are shared to cater for student's questions on certain specific topics.

4. STUDENT ATTAINMENT

Student attainment is measured using two ways, the first is based on their final grade, and the second through PO attainment. The student attainment was also compared with 3 previous academic session when the teaching method was still predominantly face-to-face to observe any obvious differences. The results are presented in percentages rather than the actual number because the total student for each academic session varies.

The result of the student's final grade is grouped into 3-grade groups which are A to B, B- to C, and C- to

E to observe the overall student grades. Figure 6 indicates that the number of students who got the highest group of grades is not affected when the teaching style is converted to online methods. Despite not having any student obtaining grade A in this academic session, there is a significant increase in the number of students who got B. On the other hand, online learning has reduced the number of students who got the lowest group of grades. Consequently, the number of students who got the middle group of grades increased significantly compared to the previous academic sessions.

The PO attainment of the EM course is shown in Figure 7. Based on this figure, the attainment for PO1 has increased significantly compared to the previous academic session. On the other hand, the attainment for PO2 has decreased to about 30% compared to the previous academic session. The effect of online learning can be observed clearly through PO attainment. The results serve as an indicator that online learning may help improve the understanding of the student in applying mathematics, science, and engineering knowledge as required in PO1. This is because online learning especially through pre-recorded videos allow the student to focus only on parts that are difficult for them.

However, online learning alone could not help the student to understand how to identify, analyse, and find solutions for complex engineering problems as specified in PO2. This is because, to attain PO2, the student needs extra guidance and discussion among their colleague and lecturer. Therefore, a combination of both face-to-face and online learning should be implemented to achieve the PO2 target.

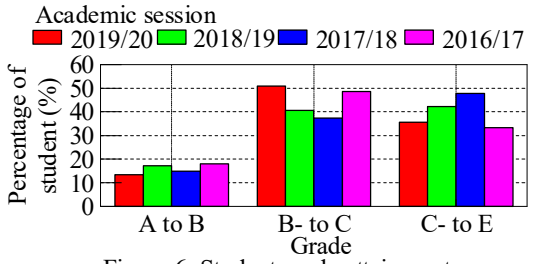

Figure 6. Student grade attainment.

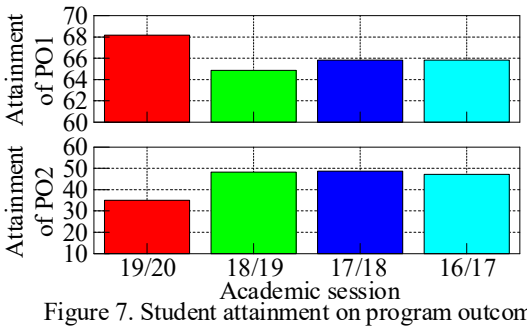

Figure 7. Student attainment on program outcome.

5. CONCLUSION

Due to Covid-19 pandemic, the traditional face-to-face teaching style was replaced by online teaching completely that not a normal practice for most of the electrical engineering program in Malaysia. This is especially true for the EM course that contains abstract and extensive mathematical applications. Therefore, the effect of online teaching on student attainment of the EM course was focused. Based on the survey conducted among all students, a combination of synchronous and asynchronous online teaching was implemented to balance between the students who have limited access to the internet and to address questions and verify problems. As a result, it is shown that online learning has the potential to assist the student in grasping basic knowledge and applying it to solve EM problems. However, the face-to-face online session is still needed to coach the student in analyzing and searching for solutions related to EM problems.

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REFERENCES

[1] Baktur, R. (2019). Teaching Electromagnetics and Antennas Using Free Software and Online Calculators, *2019 URSI International Symposium on Electromagnetic Theory (EMTS)*, San Diego, CA, USA, 1-2.

[2] Selvan, K. T. & Wahid, P. F. (2015). Teaching electromagnetic theory: Beyond a focus on applications, *2015 IEEE 4th Asia-Pacific Conference on Antennas and Propagation (APCAP)*, Kuta, 245-246.

[3] Wong, S. Y. & Lim, S. Y. (2019). Towards a Livelier Electromagnetic Education with an Interactive MATLAB-based GUI, *2019 IEEE Asia-Pacific Conference on Applied Electromagnetics (APACE)*, Melacca, Malaysia, pp. 1-4.

[4] Patil, S., Ramakrishna, S., Kelagadi, H. M., Priyatamkumar & Shettar, R. B. (2018). Technology Enabled Active Learning for Electromagnetic Waves and Theory, *2018 IEEE Tenth International Conference on Technology for Education (T4E)*, Chennai, 225-226.

[5] Lager, I. E., Vandenbosch, G. A. E. & Stumpf, M. (2020). Electromagnetism in the Electrical Engineering Classroom: Dominant trends in teaching classical electromagnetic field theory and innovation vectors. *IEEE Antennas and Propagation Magazine 62(2)*, 14-23.

[6] Serteller, N. F. O. & Kari, G. (2019). Understanding the Foundations of Electromagnetic Field Theory with Computer Software, *2019 IEEE Global Engineering Education Conference (EDUCON)*, Dubai, United Arab Emirates, 755-760.

[7] Basilio, L. I., Campione, S., Warne, L. K. & Langston, W. L. (2017). Electromagnetic theory at Sandia National Laboratories, *2017 International Conference on Electromagnetics in Advanced Applications (ICEAA)*, Verona, 1879-1882.

[8] Degraeve, A., Peuteman, J., Pissoort, D., Leuven, K., Bruges, C. & Armstrong, K. (2018). Teaching

EMC using an EMC demonstration unit. doi: 10.1109/ISEMC.2018.8393990.
[9] Engineering Programme Accreditation Standard, (2020). Board of Engineer Malaysia.

