

TEACHING EFFECTIVENESS FOR ENGINEERING FOURTH YEAR UNDERGRADUATE LEARNING DURING SCHOOL RESTRICTIONS

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Abstract

The school restrictions caused by pandemics have changed the teaching strategy. This study aims to examine the effectiveness of teaching strategies with the aids of a learning management system on student performance. A fourth-year course called Concurrent Engineering course of Faculty of Manufacturing Engineering at the Universiti Teknikal Malaysia Melaka was selected to demonstrate the merits of the strategies. The course was offered once per year which is only semester 2 every session. For this purpose, a set of the questionnaire was distributed to 33 students after the summative assessment. The teaching effectiveness was measured through course contents, knowledge, attitude, students' satisfaction that adopted from existing literature. The results of the study were analyzed using descriptive analysis involving mean and standard deviation. Teachers' attitude is the most influential factor for teaching effectiveness. The highest item in this factor is the teacher has created a teaching and learning environment that stimulates positive learning attitudes of students with a mean of 4.35 and standard deviation of 0.689. The impact of teaching effectiveness can be seen from the results of formative and summative assessments. The results show that the overall performance of students was good with 6.25% students attained grade A-. The performance is better in comparison to the previous session. And indicated that the new teaching strategy does not result in a decrease in student performance below what is normally achieved. The findings of this study show that technology is a must and must be parallel to teachers' attitude cannot be ignored to deliver effective teaching that can stimulate a positive learning environment.

Keyword: teaching effectiveness, online learning, school restrictions, engineering, satisfaction.

1. Introduction

Online learning is not new in higher education as the result of Covid19. However, the Covid19 outbreak that broke out in early 2020 has a significant impact on the lives of people around the world [1] In Malaysia, like many countries around the world, the Movement Control Order (MCO) was enforced to flatten the curve of the spread of Covid-19. The Ministry of Higher Education announced that all public and private universities in Malaysia are to conduct teaching and learning activities via online learning until the end of December 2020 (Malaysian Ministry of Higher Education, 2020). The academic fraternity was very resilient, quick to adapt, and proactive in overcoming the challenges presented by MCO. Lessons, projects, groups work, presentations, and assessments were all prepared within two weeks and carried out with the aid of technology. Although it is undeniable that online learning is deemed the best solution to ensure continuity in learning in the era of what has been coined the "new norm", there may be some setbacks such as lack of human touches such as sensing students' incomprehension via facial expressions, cracking small jokes to enlighten mood, student engagement, and interaction which can be done more effectively in traditional face to face learning. The absence of social interaction and the inability to form study groups previously enjoyed by students are also some of the challenges they now have to contend with.

Universiti Teknikal Malaysia Melaka, a public university in Malaysia that is a technical university in nature, started online learning since date using the Learning Management System (LMS) known as ULearn. The platform for online learning has been

developed since 2014 to promote flexible learning. At early usage of ULearn, are required to achieve 30% of blended learning (BL) through ULearn. The concept of BL was introduced to most disciplines by combining traditional face-to-face teaching and online communications. It is aimed to prepare the students for self-directed learning, the overall satisfaction towards the theory and real practices are still scarce [2].

Many studies concern about the effectiveness and readiness of online learning from the students' perspective [3], lack of studies on online teaching delivery. The objective of this study is to investigate the effectiveness of teachers delivering the lecture and the ability to create a positive online environment. The results of students were presented to relate the effectiveness of the teacher.

2. Methodology

2.1 Context and participants

The respondents in this study are online and distance learning (ODL) students who are enrolled in an elective course for session 2019/2020 namely Concurrent Engineering in the Fakulti Kejuruteraan Pembuatan, Universiti Teknikal Malaysia Melaka (UTeM). The course was conducted in two modes: the traditional mode for the first seven weeks and the online mode using Webex for the second half of the teaching weeks. The results of this present study are based on two modes. Most of the summative assessments were conducted during the school restrictions. Two teachers were assigned to teach the course. The course has four Course Learning Outcomes (CLO) which are: (1) Explain the concurrent engineering principles in the product development process; (2) Apply various design tools to analyze the product; (3) Produce and evaluate the alternative design that concerns with concurrent engineering technique and approach, and (4) Demonstrate the design on concurrent engineering in a group design project. Table 1 shows the assessments for the course.

All students were enrolled in the university's online LMS known as ULearn. The LMS was mainly used as a repository for teaching materials, assignments, and class announcements. The assessments for this course are presented in Table 1.

Table 1. The assessments

NO.	EVALUATION CRITERIA	CLO				Assessment mode	% distribution
		1	2	3	4		
1	Project				/	Group and self-study	15
2	Assignment 1	/				Group and self-study	5
3	Midterm Test	/	/			Online	20
4	Final Exam	/	/	/		Online	60
TOTAL							100

2.2 Instruments

Based on previous research, the current study has developed a survey instrument. An online questionnaire using Google Form was sent out via WhatsApp to a total of 32 fourth-year undergraduate students. Only 28 students participated in the survey and consist of 61% and 39% of male and female students, respectively. Most of the students

took design courses as elective courses in the fourth year with n=23, followed by process courses as elective courses with n=3 and robotics courses with n=2.

The questionnaire was adopted/adapted and reworded in the form of an online survey. All items used a 5point Likert scale ranging from 1 to 5 from "strongly disagree" to "strongly agree." The questionnaire items of course contents, knowledge, attitude, students' satisfaction were adopted from [4]; [5]. The questionnaire was distributed from 25 – 31 July 2020 which is after their final examination.

Table 2. The statements for the questionnaire

#	Statements
Course contents	
1	The course appears intellectually challenging and stimulating.
2	The course formative aims are in line with those of the course of study.
3	The course syllabus is coherent with the course formative aims.
4	The course contents have not been already treated in other courses.
5	The course is as much difficult as any other semester course.
6	The course contents are useful to complete the project and assignment.
7	The course structure shows a good balance between theory and practice.
Knowledge	
8	The teacher explicitly introduced the course descriptions (Objectives, requirements, LOs, assessment methods, course books, and reference books) at the beginning of the course.
9	The teacher has ensured appropriate professional knowledge.
10	The teacher has used appropriate teaching methods so that teaching and learning reach the course objectives.
11	The teaching content has been in alignment with the expected learning outcomes of the course.
12	The teacher's teaching strategy has enabled students to acquire and use knowledge academically.
13	The teacher has continuously updated practical knowledge into lectures.
Attitude	
14	The teacher has created a teaching and learning environment that stimulates the positive learning attitudes of students.
15	The teacher has used appropriate technology to support teaching and learning.
16	The teacher has shown enthusiasm and responsibility in teaching.
17	The teacher has consistently and adequately responded to students' questions related to the course.
18	The teacher has used appropriate assessment methods.
19	The teacher has assessed students fairly.
20	The teacher has practiced proper attitudes towards students.
21	The teacher used instructional techniques like group discussions and student presentations to reach the objectives of this course.
22	The teacher was reachable out of the classroom and showed open concern towards the students.
Students' satisfaction	
23	How much have you learned in this course (in terms of skills, knowledge, analytic capabilities, etc.)?
24	Would you recommend this course to a fellow student?

2.3 Data Analysis

The data were analyzed using descriptive analysis. As the number of the respondent is small, Microsoft Excel was used to analyze the data. Table 3 provides reliability values for the items. The overall reliability was calculated using the Cronbach alpha value.

3. Results and Discussion

3.1 Reliability

The overall Cronbach alpha value was 0.974. The Cronbach's alpha coefficient for all items is shown in Table 2 which indicates that all the items in the questionnaire are reliable.

Table 2. Reliability Test of the Questionnaire

Dimension	# Items	Composite reliability
Courses	8	0.882
Teachers' knowledge	6	0.916
Teachers' attitude	10	0.963
Students' behaviour	2	0.708

3.2 Demographic results

This section presents the demographic characteristics of 28 respondents that considered the gender and which are other electives taken by respondents. The composition of the gender had a male representation of (61%) as compared to (39%). This indicates that this course is favored by males and it is common in engineering faculty. The study sought to find out there are a few students who have a different background from Manufacturing engineering design took Concurrent engineering as an elective course. Although it is a small number, this gives signals on the attractiveness of the Concurrent engineering course. Respondents enroll in to process course counted for (11%) while the robotic and automation course had a representative of (7%).

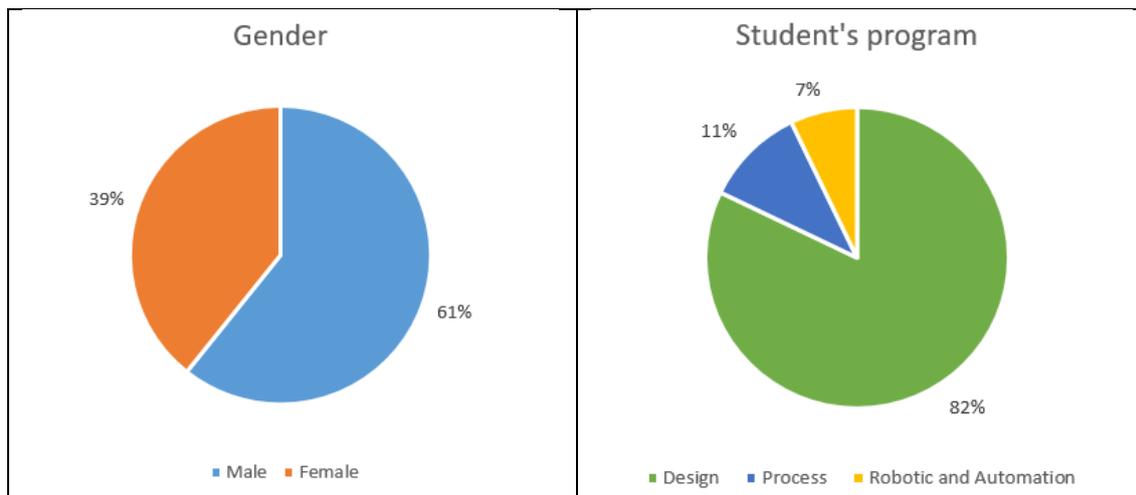


Figure 1. Gender of respondents

Figure 2. Students' program

3.2 Questionnaire results

Microsoft Excel was used to present the descriptive statistics of each construct. The mean and standard deviation values of each construct in this paper have been evaluated in the next section.

The first part of the questionnaire was about the course contents which consists of seven items utilizing the 5-point scale ranging with the statement from very disagree to very agree. The first overall mean of all the items is 4.192. As shown in Table 3, the highest mean belongs to “The course formative aims are in line with those of the course of study” and “The course contents are useful to complete the project and assignment” with (M=4.35 and SD=0.689 and 0.797, respectively). It is followed by “The course appears intellectually challenging and stimulating” and “The course syllabus is coherent with the course formative aims” with (M=4.27 and SD=0.667). “The course contents have not been already treated in other courses” with (M=3.85, S.D=0.881) have the lowest mean score.

Table 3. Descriptive statistics for course contents

Items	M	SD
The course appears intellectually challenging and stimulating.	4.27	0.667
The course formative aims are in line with those of the course of study.	4.35	0.689
The course syllabus is coherent with the course formative aims.	4.27	0.667
The course contents have not been already treated in other courses.	3.85	0.881
The course is as much difficult as any other semester course	4.12	0.952
The course contents are useful to complete the project and assignment.	4.35	0.797
The course structure shows a good balance between theory and practice.	4.15	0.732
Total	4.192	

It is important that the assessments are related to the contents of the course. The purpose of the given assessments is to improve their understanding of the course contents. In this course, students were given one assignment and one project. The project is a group assessment in which parallel with the concurrent engineering principle of working in a team. The assignment is related to failure modes and effects analysis (FMEA). Students are required to propose a design and implement the FMEA process. Students are required to submit in the form of a report as shown in Figure 3.

Failure modes and effects analysis (FMEA)

Project: Date:

Prepared by:

SEV = How severe is effect on the customer?
 OCC = How frequent is the cause likely to occur?
 DET = How probable is detection of cause?
 RPN = Risk priority number in order to rank concerns; calculated as SEV x OCC x DET

System / Function	Potential failure mode	Potential Effects of the Failure Mode	SEV	Potential Causes of the Failure Mode	OCC	Current process controls	DET	RPN	Actions recommended	Resp	Actions taken	NSEW	NOCW	NDET	NRPWN
Handle / Provide steering control	Handle is uncomfortable	User uncomfortable	6	a) Handle doesn't fit user size b) Handle has sharp edge c) Handle has loose screw d) Gripper easy to loose	4	a) Measure target user size b) Round all edges c) Tighten the screw d) Change gripper material	5	120	Design review of the part, Review the dimension measure	Mr. Muaz	Redesign ready for next process	6	2	4	48
Deck / Provide stand comfort	Deck Breaks	Sharp edged exposed, Deck Collapses, User is injured	10	a) Plate to weak b) Deck to thin c) Fastener holes shear d) User used in rough road	3	a) Plate analysis b) Stress Analysis c) Impact Factor Analysis d) Equip Prevention (Warning) Manual	3	90	Design review of the part	Mr. Syuz	Redesign ready for next process, Introduction of the Prevention Manual	4	2	3	24
Deck / Support user weight	Deck flexes too much	User feels unstaibles	7	a) Plate to weak b) Deck to thin c) Kickstand easily dented e) Fastener loosen f) Material deck easily bend g) User over weight	5	a) Plate analysis b) Stress Analysis c) Impact Factor Analysis d) Deflection / Strain Analysis e) Fastener Shear Analysis f) Selection Material Analysis g) Weight user	6	210	Design review of the part	Mr. Mus & Mr Pen	Redesign ready for next process	7	1	5	35
Brake / Hold user stop	Brake wears down over time	User injures / fall / accident	10	a) Brake size doesn't fit user b) Brake material easily slipped c) Tires wears down over time	7	a) Measure target user size b) Brake Shear Anlysis c) Selection Material Analysis d) Add alternative brake system	8	560	Design review of the part, Review the dimension measure, Review the new alternative brake system	Mr Syah	Redesign ready for testing	5	2	8	80

Figure 3. Example of assignment report

The second part of the questionnaire was about the teacher's knowledge. To address the measurement of teachers' knowledge, seven items were designed using the 5-point scale ranging with the statement from very disagree to very agree. Based on Table 4, the overall mean of all items is 4.128. The highest mean belongs to "The teacher explicitly introduced the course descriptions (Objectives, requirements, LOs, assessment methods, course books, and reference books) at the beginning of the course" with (M=4.27 and SD = 0.724) followed by "The teacher has ensured appropriate professional knowledge" with (M=4.15 and SD = 0.732). This item shares the same value mean with "The teacher's teaching strategy has enabled students to acquire and use knowledge academically" (SD=0.784) and "The teacher has continuously updated practical knowledge into lectures" (SD=0.784). The lowest mean score is "The teacher has used appropriate teaching methods so that teaching and learning reach the course objectives" with (M=4.15 and SD = 0.732).

Table 4. Descriptive statistics for teachers' knowledge

Items	M	SD
The teacher explicitly introduced the course descriptions (Objectives, requirements, LOs, assessment methods, course books, and reference books) at the beginning of the course.	4.27	0.724
The teacher has ensured appropriate professional knowledge.	4.15	0.732
The teacher has used appropriate teaching methods in order that teaching and learning reach the course objectives.	3.96	0.662
The teaching content has been in alignment with the expected learning outcomes of the course.	4.08	0.628
The teacher's teaching strategy has enabled students to acquire and use knowledge academically.	4.15	0.784
The teacher has continuously updated practical knowledge into lectures.	4.15	0.784
	4.128	

At every beginning of the class, the teacher explains their teaching planning, the course learning outcomes, and assessments. With the help of Ulearn (Figure 4), the teacher able to display the objectives, requirements, LOs, assessment methods, course books, and reference books throughout 14 weeks. During the 14 weeks, various activities to enable students to acquire and use the knowledge academically were designed as shown in Figure 5. The mean value of 4.15 shows that various activities in the classroom facilitate respondents to improve learning. This is supported by [6].

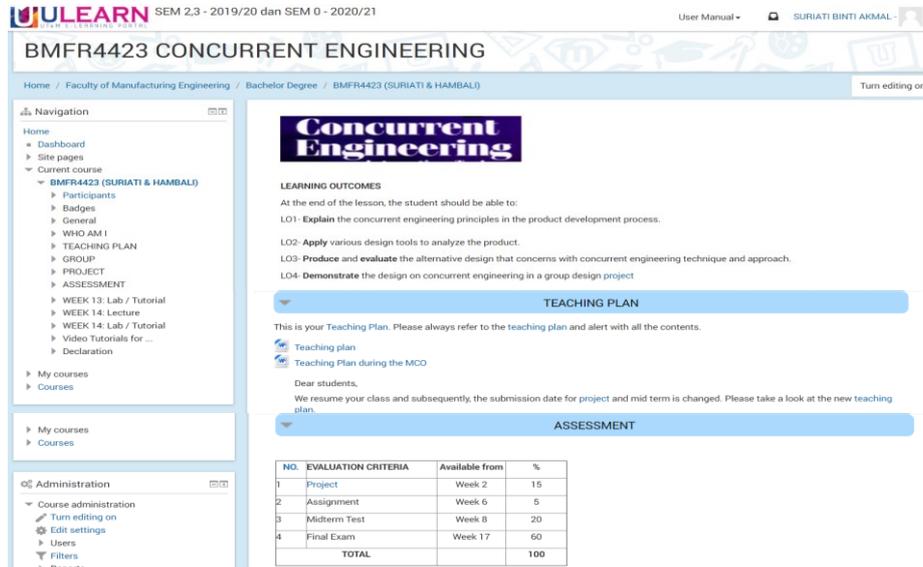


Figure 4. The interface of Ulearn for the assessment column

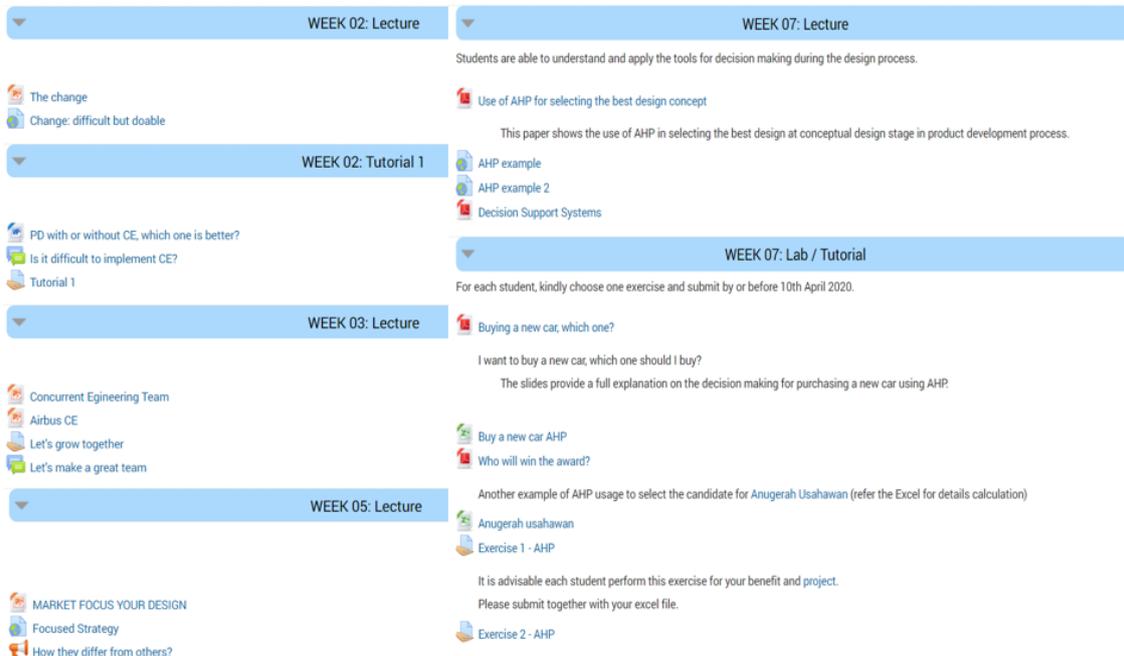


Figure 5. The class activity

The third part of the questionnaire was about the teacher's attitude. To address the measurement of teachers' knowledge, nine items were developed using the 5-point scale ranging with the statement from very disagree to very agree. Based on Table 5, the overall mean of all items is 4.197. The highest mean belongs to "The teacher has created a teaching and learning environment that stimulates positive learning attitudes of students" with (M=4.35 and SD = 0.689) followed by "The teacher has used appropriate technology to support teaching and learning" with (M=4.23 and SD = 0.765). The lowest mean score is "The teacher has assessed students fairly" with (M=4.12 and SD = 0.711).

Table 5. Descriptive statistics for attitude

Items	M	SD
The teacher has created a teaching and learning environment that stimulates the positive learning attitudes of students.	4.35	0.689
The teacher has used appropriate technology to support teaching and learning.	4.23	0.765
The teacher has shown enthusiasm and responsibility in teaching.	4.19	0.749
The teacher has consistently and adequately responded to students' questions related to the course.	4.19	0.939
The teacher has used appropriate assessment methods.	4.15	0.675
The teacher has assessed students fairly.	4.12	0.711
The teacher has practiced proper attitudes towards students.	4.15	0.543
The teacher used instructional techniques like group discussions and student presentations to reach the objectives of this course.	4.19	0.567
The teacher was reachable out of the classroom and showed open concern towards the students.	4.19	0.749
Total	4.197	

In Ulearn, there is an option of many learning activities such as forums and feedback. This is one simple method to create a positive learning environment. A forum is a section where respondents provide their opinion on the question given. As shown in Figure 6, it is an example of a forum on the question of "concurrent engineering difficult to implement?". The activity was implemented during the class session. Respondents were allowed to discuss in their team and refer to an online textbook or online sources. They were required to answer the question with references. In learning of subchapter market focus, where respondents were exposed to the importance of engineers to understand the market by investigating the customer satisfaction. During the class, the market strategy of the three biggest companies was discussed. The respondents were required to provide feedback from the discussion. Figure 7 shows the respondents' feedback on the topic and the mean value of 4.35 and 4.23 prove that technology in the classroom has created a positive learning environment. These findings are supported by [7].

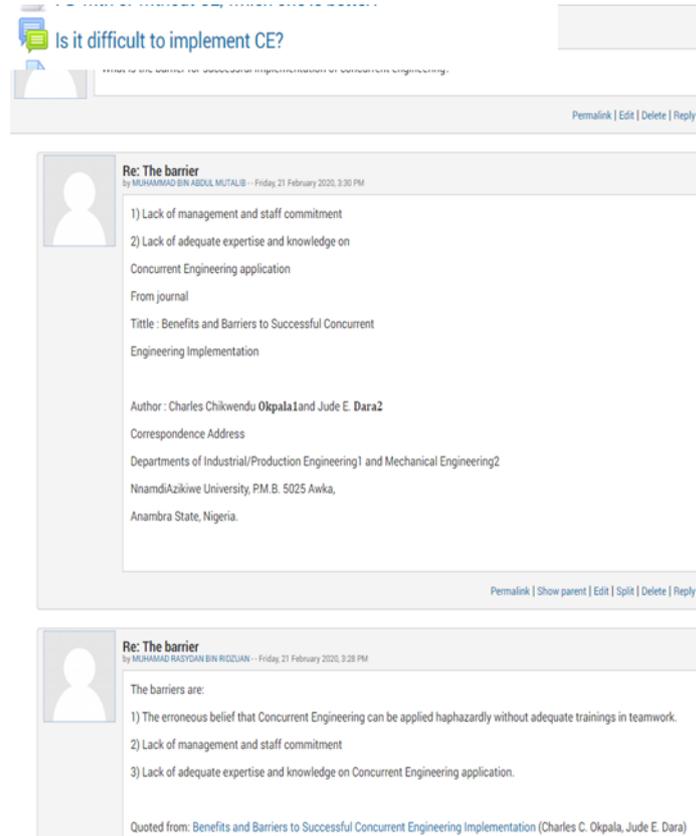


Figure 6. Example of forum

Response number	Select one of the company mention in the slides.	If you select chanel, answer the following: what are their focused strategy to be the market leader in the fashion industry?	If you select Gucci, answer the following: How Gucci use demographic and psychographic segmentation strategies to be the market leader?	for 4 seasons hotel, explain one of their market strategy?
Response number: 1	4 seasons hotel			Fulfils all the customer needs in term of luxury
Response number: 2		-Social rise of chanel -crafting a luxury video strategy		
Response number: 3	Gucci	Social media and promotion through the video	To identify different segmentation variable and come out with offering ahead than others.	
Response number: 4	Channel	-Crafting a luxury video strategy -multi-platform and multi purpose content - differentiate content and promotion		
Response number: 5	Chanel	Put an online video on the youtube and facebook to gain the followers		
Response number: 6	Gucci		To identified the different segmentation variable and come out with offering which are way ahead of its time in the fashion industry. Gucci also used selective target strategy. By using demographic Gucci may knows the variety range of user thus, designing can be focused on certain age or gender range. By psychographic, Gucci gain platform to improve their product to meet customer needs.	

Figure 7. Respondents' feedback on the market focus

The fourth part of the questionnaire is the respondent’s satisfaction with teaching. Some literature argues that satisfaction is related to teaching effectiveness [7]. To address the measurement of teachers’ knowledge, two items were developed using the 5-point scale ranging with the statement from very disagree to very agree. Based on Table 6, the overall mean of all items is 3.981. The highest mean belongs to “How much have you learned in this course (in terms of skills, knowledge, analytic capabilities, etc.)?” with (M=4.12 and SD = 0.711) followed by “Would you recommend this course to a fellow student?” with (M=3.85 and SD = 1.156). The later question shows that they are not sure will promote this course to others. This is probably due to the course contents were designed specifically for the Manufacturing Design program. They may recommend this course to others not according to contents but the teacher. Students tend to rely on the word-of-mouth and instinct of their feeling rather than using benchmarks of course satisfaction when rating the teaching effectiveness of their teachers [8].

Table 6. Descriptive statistics for satisfaction

Items	M	SD
How much have you learned in this course (in terms of skills, knowledge, analytic capabilities, etc.)?	4.12	0.711
Would you recommend this course to a fellow student?	3.85	1.156
Total	3.981	

In summary, teachers’ attitude is seen as the most influential factor for effective teaching strategies.

Factors	M
Course contents	4.192
Knowledge	4.128
Attitude	4.197
Students’ satisfaction	3.981

3.3 Students’ Results

Table 8 shows the overall results of the course. The faculty categorizes the overall results into excellent, good, moderate, and poor. Excellent if the distribution is a normal curve (bell shape) and grade A- and A is approximately 20% of total students. While very poor if grade E is greater than 10% of total students. The minimum passing mark for the course is D.

For this course, it is categorized as good where 6.25% students attained grade A-, and 11% students attained C- and below for this course. No student fail in this course. Students were not achieving good results due to lower marks in summative assessment (final examination) which is less than 40%. Traditionally, the final examination was administered as a 3-hour written examination with full supervision by invigilators and containing structured short answer and essay-type questions. As a result of school restrictions, the university decided to administer the final examination as an online final examination with the lecturer as the invigilators. The questions are set up as an open-ended questions. It was conducted in an online environment using UTeM’s Ulearning hub. Students still have 3-hour to download, answer and upload their script to UTeM’s Ulearning hub platform.

Most formative assessments were conducted in a group as suggested by the Concurrent Engineering principle. However, they cannot apply individually especially during the final examination as can be seen in Table 8. The results indicate that the course contents are challenging although the teacher has put a big effort to create a positive learning environment during classes by creating many discussions. The discussion prepared students to think about the knowledge beyond the slides and textbook.

In comparison to the results of the previous semester (Table 8), the results were not much different. In both sessions, all students pass the course. The student performance for session 2019/2020 better than the other with 5 students got A- and above. The final exam was an online exam and students had to access reading materials to assist attempt of the exam questions.

Table 8. Comparison student performance for two sessions

Session	Grade										Total
	A	A-	B+	B	B-	C+	C	C-	D+	D	
2019/2020	0	5	2	4	4	3	4	6	4	1	33
2018/2019	2	2	9	6	8	4	2	0	1	1	35

Figure 8 shows the comparison of results by gender for session 2019/2020. It shows that most of female students got grade A- and B-. In comparison against male students, most of them got grade C- in this course. Let say the best results is between A and B-, female students shows good performance which indicates they capable to understand the teaching and learning for both modes that implemented for this course.

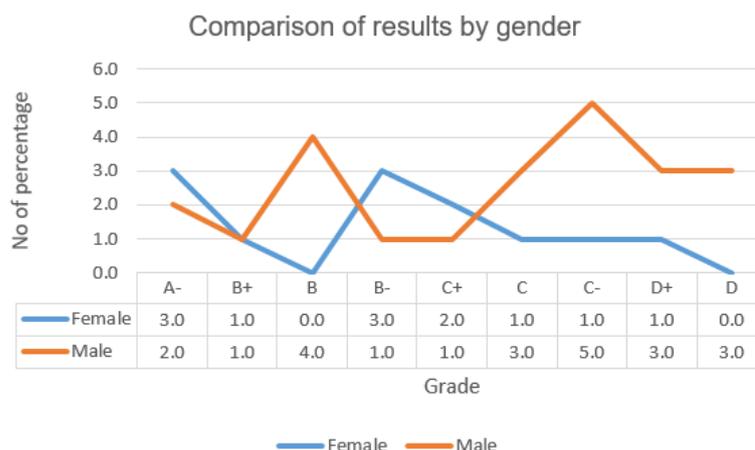


Figure 8. Comparison of results by gender

The questionnaire indicated that new strategies in teaching and learning that highly depend on technology are required. It significantly helps teachers to be aware of the students' perceptions about this course and enhancing their teaching effectiveness. More fun activities such as web research, Kahoot! Quizzes, case studies, peer discussion, and talk with experts from industries shall be conducted to support teaching.

4. Conclusion

This article presented effective teaching for fourth-year undergraduates during school restrictions. A Concurrent Engineering course was selected to demonstrate the effectiveness of teaching. The results indicate that there is great merit in the use of online learning platforms to support the teaching of Concurrent Engineering course at the university during school restrictions. Although the results of students in session

2019/2020 appear to be consistent with the previous session that was conducted in fully traditional techniques, there is no evidence to suggest that students did not collaborate or cheating while answering the online examination. During the school restrictions, the most important is technology and internet access. The absence of both could hinder the use of teaching strategies. Research in this article has shown that the new teaching strategy does not result in a decrease in student performance below what is normally achieved. The article shows that it is good to know which methodology results in better student performance. Although technology is a must, teachers' attitudes cannot be ignored in order to deliver effective teaching that can stimulate a positive learning environment.

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