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Students' satisfaction on learning calculus using open and distance learning method during COVID-19 pandemic

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ABSTRACT

In early 2020, due to the COVID-19 outbreak in Malaysia, all higher education institutions had to switch from face-to-face learning to open and distance learning (ODL) method. The main purpose was to prevent any further spread of the COVID-19 virus. This study aimed to identify factors carrying impacts on students' satisfaction in learning calculus using ODL method. The sample consists of 224 students of Universiti Teknologi MARA (UiTM) Perak Branch, Tapah Campus who took calculus subjects using ODL method during the COVID-19 lockdown in Malaysia. Five factors are found to influence students' satisfaction towards ODL method: student-lecturer interaction; lecturer performance; ODL course evaluation; design; and technical. By using partial least square (PLS)–SEM method, the results showed that lecturer performance has a large effect size on students' satisfaction. Technical and design factors have medium effect sizes, while the ODL course evaluation and student-lecturer interaction have small effect sizes. This research provided useful insights for an effective planning of online calculus courses by considering all factors that influence students' satisfaction.

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1. INTRODUCTION

In Malaysia, the first COVID-19 outbreak happened in early 2020. The government had imposed a 14-day nationwide movement control order (MCO) beginning on March 18th to 31st, to prevent any further spread of COVID-19 in the country. Since then, the Malaysian Prime Minister announced the closure of all public and private higher learning institutions. Universities immediately switched their curriculum from face-to-face to open and distance learning (ODL) to cope with the enforced MCO.

ODL is already an approach used worldwide, even before the COVID-19 outbreak. For instance, in previous study [1], ODL was found to have been used widely in the higher education sector. Many studies have found that online learning has positive effects, such as improved test results, more student engagement, greater social connections, and favourable attitudes toward learning [2]. Universiti Teknologi MARA (UiTM) has put a proactive measure by introducing the ODL method, operating through online learning. The experience in massive open online course (MOOC) put an advantage to UiTM in developing the ODL courses and design. According to Aziz [3], UiTM started to develop MOOC in 2014 and was created 450 new MOOCs in 2017. ODL offers open access to education and has a flexible learning time and place [4]. The ODL mode uses online platforms such as Google Meet, Google Classroom, WhatsApp, Telegram,

i-Learn (UiTM's online platform for teaching and learning), YouTube, Zoom, and Skype. Previous researchers [5] found that the majority of the students prefer using WhatsApp and Google Meet as online platforms for both teaching and learning.

According to Anderson [6], online learning develops student's ability to share information, insights, build and work very effectively. However, there are few issues were highlighted because of the drastic transformation from face-to-face learning to an ODL method. The issues highlighted are lack of students' equipment, internet coverage distraction, financial and environment at home [7], [8]. In addition, most lecturers come from conventional educational institutions and have no prior experience teaching in ODL method. Previous study [9] indicated that university students in Malaysia were between slightly to moderately ready for online learning, and some of them were still unready due to the lack of learners' control, self-directed learning, and online communication efficacy. The majority of students had a lot of distractions at home, which affected their focus and understanding of the lessons [10].

The challenges that the students must face during this period of the pandemic are intense and precipitous. Mathematics, particularly the calculus course, is one of the challenging courses for undergraduates. This course involves learning through tutorial practices to ensure the students' better understanding of the topic. To adapt with the changes from the previous face-to-face learning to the current online learning, Ichinose [11] believed that synchronous activities are effective for the learning of mathematics. Since it is the first time for UiTM to implement online learning for the whole semester for years 2020 and 2021, a study needs to be done to measure the students' satisfaction on learning mathematics, particularly for the calculus course that uses ODL method. This could lead to future improvements in teaching delivery by calculus lecturers of UiTM Perak Branch, Tapah campus.

2. LITERATURE REVIEW

This section contains a review of research work relevant to the work presented in this study. Online learning has a very different environment compared to the traditional classroom. The COVID-19 outbreak had forced many institutions to switch their teaching mode from face-to-face to online teaching. Thus, the institutions must be able to identify the possible factors that influence the students' satisfaction in online learning. In this literature review, the focus is on student-lecturer interaction, lecturer performance, ODL course evaluation, design, and technical factors.

2.1. Student-lecturer interaction

The first factor is student-lecturer interaction. According to previous researchers [12]–[16], the effectiveness and success of online learning depend on the level of interaction which is an essential element of student learning. A high frequency of student-lecturer interaction is required to have successful online learning. Interactions between students and lecturers, and students and students are an important element for learning to occur [17]. Regular and healthy interactions can enhance students' learning experience and satisfaction, helping them feel a better connection, and leading to better retention and engagement.

As to boost students' interactions, lecturers should engage their students in the online discussion, encourage student to student interactions, and reward a participation mark [18]. In online learning, easily accessible information, assistance, and feedback by the lecturer determine a student's satisfaction. Liu and Cavanaugh [19] found a significant positive effect of the number of learner-teacher interactions on final scores in an online high-school algebra course. Based on the review of the previous literature, the authors hypothesize that: High frequency of student-lecturer interaction will be positively related to the students' satisfaction (H1).

2.2. Lecturer performance

Lecturer performance is the second factor that contributes to students' satisfaction of ODL. The success of the implementation of ODL is based on the lecturer's attitude towards ODL. The lecturer's teaching style, lecture-delivery approach, and quality-content provision are the factors that influence students' satisfaction and acceptance of online education [20], [21].

According to previous study [22], lecturers are the key players in planning, implementation, and delivering content. Lecturers can motivate students through interesting and interactive content in their online learning activities, and by delivering lectures in a friendly manner. Online learning also requires the lecturer to act as a facilitator, guide, coach, and mentor [23]. Lecturers should also have sufficient computer knowledge to make online learning run smoothly [24]. Therefore, it is hypothesized: Lecturer performance will be positively related to the students' satisfaction (H2).

2.3. ODL course evaluation

Course evaluation is the third factor affecting students' satisfaction. Course design refers to curriculum knowledge, program organization, and course structure including learning activities, content sequencing, and assignment structure [25], [26]. According to previous research [27], clear assignment rubrics and guidelines are important for students' satisfaction on online learning. In designing ODL courses, it is essential to meet the needs and perceptions of the students as the key consideration. Courses that fail to meet students' expectations and needs can lead to a low level of student engagement. ODL has removed physical barriers to class attendance. It offers the flexibility of location and time for both lecturers and students. This feature makes ODL more attractive than the traditional classroom. A well-delivered course has a positive effect on students' perceived usefulness towards the course [28]. According to several studies [29]–[31], the quality of course content is the most important feature that leads to students' satisfaction and successful implementation of online learning. Hence, it is hypothesized that: ODL course evaluation will be positively related to the students' satisfaction (H3).

2.4. Design

The fourth factor is the design or interface factor. The design of the system will contribute to students' satisfaction for ODL mode [32]. The user-friendly and easy-going interface of the online course will attract students to join the online class [33]. The students' positive attitude towards the interface will directly influence their satisfaction towards online learning. The discussion also leads the authors to formulate the following hypothesis: Design factor will be positively related to the students' satisfaction (H4).

2.5. Technical

Technical is the fifth factor which plays an important role in implementing an effective and efficient ODL method. The excellent quality of technologies will influence students' satisfaction towards online learning [20], [34]. Online learning requires a high-speed internet connection. The different platforms of online learning include using different tools like video lectures or text-based instructions. When students have zero problem to login and logout, their satisfaction towards ODL will be improved. Lastly, it is hypothesized that: Technical factor will be positively related to the students' satisfaction (H5).

3. RESEARCH MODEL

The research model is adopted from previous studies [33], [35]. There are five independent variables and one dependent variable as illustrated in Figure 1. All the hypotheses were constructed based on this research model.

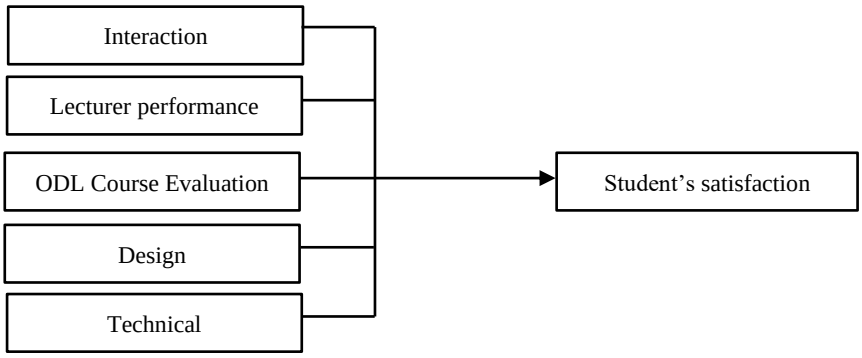

Figure 1. Research model

4. RESEARCH METHOD

Partial least square (PLS)–SEM was employed to analyze the relationship between the latent variables based on the research model. The research model was validated using reliability, convergent validity, discriminant validity and hypothesis testing [36], [37]. As this study focuses on ODL, the sample consisted of UiTM students who took calculus subjects using ODL method during the COVID-19 lockdown in Malaysia. The probability sampling technique of simple random sampling was used to select the sample. Based on the student registration database, 520 students took calculus subjects and used ODL method, and we managed to get 224 samples. According to [38], this total sample is enough to represent the population.

The structured questionnaire was adapted from [33], [35]. The questionnaire uses a five-point Likert scale (1=strongly disagree to 5=strongly agree) and consists of six latent constructs (one dependent, and five independent variables) namely student-lecturer interaction, lecturer performance, ODL course evaluation, design, technical, and students' satisfaction. The questionnaire was constructed using Google Form, and the link was distributed through email and online platforms such as WhatsApp and Telegram.

5. RESULTS AND DISCUSSION

SmartPLS 3.3.3 software [39] was used to analyze the data. The procedure of PLS-SEM must evaluate the measurement model (Cronbach's alpha, loading, composite reliability (CR), and average variance extracted (AVE)) [36]. The last step is to determine the structural model (path analysis).

5.1. Measurement model evaluation

There are two main criteria used in the measurement model evaluation which are reliability and validity test. The reliability test illustrated in Table 1 was used to test the consistency of items in the instrument. Hence, the validity test illustrated in Table 2 and Table 3 was used to determine how well the construct by examining the convergent validity and discriminant validity. Table 1 shows the Cronbach's alpha values for each latent construct.

Based on the result, all latent constructs were reliable since the Cronbach's alpha values were greater than the threshold value of 0.6 [40]. Those ranging within 0.7 are acceptable values, while those over 0.8 are good values [40]. In addition, the final number of items for each latent construct was the same as the initial, since the values of the loadings were all higher than 0.7 [36].

Table 1. Reliability test (Cronbach's alpha)

Constructs	Measurement items	Cronbach's α	Number of items
Interaction	A1, A2, A3, A4	0.825	4(4)
Lecturer performance	B1, B2, B3, B4, B5, B6	0.924	6(6)
ODL course evaluation	C1, C2, C3, C4, C5	0.916	5(5)
Design	D1, D2, D3	0.887	3(3)
Technical	E1, E2, E3, E4, E5, E6	0.923	6(6)
Satisfaction	F1, F2, F3, F4, F5, F6, F7, F8	0.897	8(8)

Table 2. Convergent validity of measurement model

Construct	Item	Loadings	CR	AVE
Interaction	A1	0.849	0.881	0.650
	A2	0.864		
	A3	0.719		
	A4	0.786		
Lecturer performance	B1	0.806	0.940	0.724
	B2	0.818		
	B3	0.844		
	B4	0.847		
	B5	0.897		
	B6	0.892		
ODL course evaluation	C1	0.839	0.937	0.748
	C2	0.875		
	C3	0.902		
	C4	0.874		
	C5	0.834		
Design	D1	0.896	0.930	0.816
	D2	0.925		
	D3	0.889		
Technical	E1	0.826	0.939	0.720
	E2	0.856		
	E3	0.854		
	E4	0.875		
	E5	0.860		
	E6	0.818		
Satisfaction	F1	0.778	0.917	0.582
	F2	0.747		
	F3	0.783		
	F4	0.733		
	F5	0.800		
	F6	0.819		
	F7	0.670		
	F8	0.761		

Based on Table 2, the composite reliabilities were all greater than 0.7 and the AVE values were also higher than 0.5 as suggested by previous studies [36], [41]. Thus, the convergent validity of measures was established. Next, the discriminant validity of measures was examined using Fornell and Larcker [42] method. This method compares the correlation of latent constructs with the squared root of AVE of the latent construct. Table 3 shows that all the diagonal values were higher than the other correlation values. Thus, the discriminant validity was satisfied.

Table 3. Discriminant validity of measurement model

Constructs	Design	Interaction	Lecturer performance	ODL course	Satisfaction	Technical
Design	0.903					
Interaction	0.554	0.806				
Lecturer performance	0.630	0.718	0.851			
ODL course evaluation	0.660	0.679	0.765	0.865		
Satisfaction	0.805	0.730	0.845	0.829	0.763	
Technical	0.696	0.476	0.505	0.607	0.751	0.848

5.2. Structural model evaluation

There are three criteria that were examined in the structural model evaluation which are the relationship between the constructs, the strength of structural model, and the strength of each predictor towards students' satisfaction. The relationship of constructs and the strength of each predictor illustrated in Table 4 was examined based on path coefficient analysis (t value and coefficient (β)) and effect sizes (f^2). Furthermore, the strength of the structural model illustrated in Figure 2 was evaluated based on the coefficient of determination (R^2).

Table 4 depicts that all the predictors of students' satisfaction were tested and the result shows that technical (β=0.253, p=0.011), student-lecturer interaction (β=0.101, p=0.001), lecturer performance (β=0.368, p=0.001), ODL course evaluation (β=0.177, p=0.001) and design (β=0.225, p=0.001). Thus, all hypotheses (H1, H2, H3, H4, and H5) are supported since the p-values are less than 0.05 and 0.01.

Figure 2 shows that the R^2 was 0.920. This means, 90.20% of the total variation in the students' satisfaction was explained by all the predictors in this model. To determine the strength of each predictor towards students' satisfaction, we examined the effect sizes (f^2). The effect sizes can be categorized into three: small (0.02), medium (0.15) and large (0.35) effects [43]. Based on the f^2 values, only lecturer performance shows a large effect size on the students' satisfaction, while technical and design have medium effect sizes. The ODL course evaluation and student-lecturer interaction have small effect sizes.

Table 4. Path coefficient and hypothesis testing

Hypothesis	Relationship	Coefficient	t value	Decision	f^2
H1	Technical ⟶ satisfaction	0.253	7.137**	Supported	0.312
H2	Interaction ⟶ satisfaction	0.101	2.531*	Supported	0.046
H3	Lecturer performance ⟶ satisfaction	0.368	9.087*	Supported	0.452
H4	ODL course evaluation ⟶ satisfaction	0.177	4.228*	Supported	0.103
H5	Design ⟶ satisfaction	0.225	5.427*	Supported	0.205

*p-value<0.05, **p-value<0.01

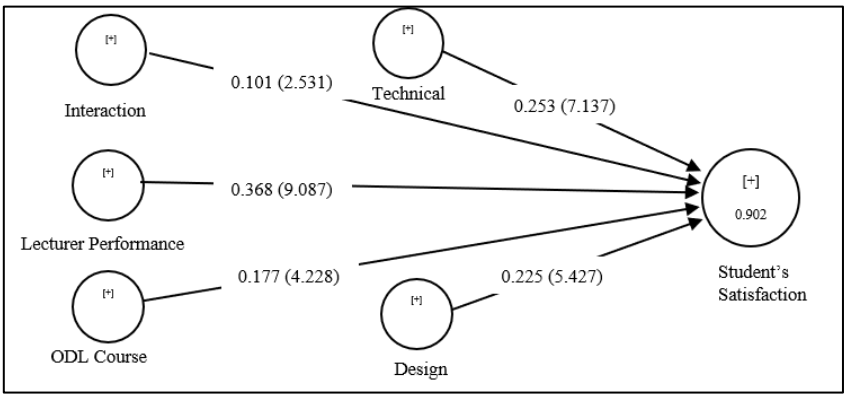

Figure 2. Result of path analysis

6. CONCLUSION

This research examined the factors that affect students' satisfaction on learning calculus using ODL method in UiTM Perak Branch, Tapah Campus during the COVID-19 pandemic. The proposed hypotheses are student-lecturer interaction, lecturer performance, ODL course evaluation, design, and technical. The study was conducted by sending an online questionnaire to 220 students who participated in ODL calculus course. The results show that the lecturer's performance has a large effect size on the students' satisfaction. The students rely on the lecturers' delivery methods of online lecturing and tutoring. Therefore, materials provided by the lecturers for the online learning process and how they handle tutorial classes are important.

Meanwhile, the technical and design factors have medium effect sizes. The other factors that have small effect sizes are the ODL course evaluation and student-lecturer interaction. Student and lecturer interaction has the smallest effect size because of the difficulties for students to ask mathematics questions that they do not understand to the lecturer, and it is also hard to understand the lecturer's explanation on an online platform. Therefore, the students prefer to find the answers online, rather than asking their lecturers. These suggest that institutions should pay more attention to the quality of ODL course evaluation and student-lecturer interaction. Improving these factors will enhance students' satisfaction towards ODL and improve their learning quality.

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