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Students' Perceptions and Constraints on Learning Calculus Courses Online

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Abstract

Calculus is one of the compulsory courses especially for undergraduate students in many fields of study. Based on the preliminary studies, most of the students reported that calculus was a challenging subject to comprehend. Meanwhile, during the Pandemic crisis, most educational institutes have transformed the initial face-to-face learning approach to online learning process in order to ensure academic activities can be carried out. This shift in the learning process can signal a brand-new issue among university students. Thus, using a quantitative approach, this study aims to explore the perceptions among Calculus courses students through online approach as well as the constraints that they face. The instrument of data collection was carried out through questionnaire. It was programmed using Google Form and distributed using Whatsapp application to the respondents consisted of 82 students from Calculus courses in Diploma in Mathematical Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus. Analysed using Microsoft Excel and SPSS version 25.0, data from the questionnaire used in the study indicates five findings regarding students' perceptions and constraints towards online learning; the two-way communication between students and lecturer is going well regardless of not having physical classes, the problem of accessing internet factor was related to students' placement factor, the non-conducive learning environment factor was related to students' adaption to online learning factor, the difficulty of having group discussion factor was related to the lack of home facilities factor and lastly, the uncomfortable of doing online presentation was related to the factor of lacking confidence in front of the camera. The findings also suggest that the educators should try to accommodate the students' needs during online teaching and learning process.

Keywords: Students' Perception, Students' Constraints, Online Learning

Introduction

Mathematics is a required subject for science and technology courses as well as several other social science courses in university. Calculus is one of the core requirement subjects for

science university students majoring in Mathematics. It is the first in a sequence of courses designed to provide the skills and concepts required to further their studies in mathematics, physics, computer science, and engineering (Aspinwall & Miller, 2013). There are many challenges in learning calculus during Pandemic COVID-19, where the learning process takes place through online learning platforms. When the COVID-19 pandemic hit the world, all sectors are affected, including education, and it is impossible to immediately stop or pause the educational programmes. The distance learning approach is one suitable method that can be utilised to mitigate the spread of the virus. As in many nations worldwide, the government has instructed all students from pre-school to higher education levels to learn from home during the emergency period of the COVID-19 virus. The face-to-face learning process has automatically switched to online learning in order to ensure the academic activities can be carried out. Home learning models recommended by the Ministry of Education include project-based learning, offline learning, home visit techniques, integrated curriculum, blended learning, and internet learning. A significant advancement in higher education has been incorporated into the process of online learning or e-learning (Yen & Lee, 2011). Hence, the students are facilitated during online classes with educators' guidance.

Everyone has experienced online learning during the COVID-19 pandemic almost all around the world (Goldschmidt, 2020). It is necessary to pursue online learning since teachers and students are the key components in the educational process. All aspects of education must be adjusted according to the new online learning environment. By involving educators and students, despite of their location, online learning must be carried out efficiently (Verawardina *et al*., 2020). While students are required to participate actively in the learning activities and comprehend the materials delivered indirectly, as is traditional classroom, teachers are required to ensure lively classes even in the absence of direct engagement.

The most well-known benefit of online education is convenience, particularly in terms of time, flexibility, and accessibility (Callaway, 2012). This online platform is vital for adult learners who cannot access a regular or traditional classroom that is already set up for their education (Ilgaz & Gulbahar, 2015). In addition, an online learning environment enables more interaction in a virtual learning environment and both horizontal (peer-to-peer) and vertical (student-to-instructor) communication at the same time. Students are thus reported to be more introspective and collaborative, and they are better equipped to apply the knowledge that they have learned. Contrarily, the majority of these university students, who need to be guided to ensure that they are engaged to the online learning platforms in order to prevent being distracted at home, encounter a number of difficulties with this online learning, especially with calculus subject. The researchers found that a few challenges that are related to online learning are flexibility, facilitating students' learning processes, encouraging engagement, and fostering a positive learning environment. The development of learning materials, motivated interactions between instructors and students, good preparation, and supportive instructors contribute to the effectiveness of online learning.

Therefore, studying how students' perception of the online learning process will help to evaluate whether online learning is successful or not (Otter *et al*., 2013). This switch to online learning platforms has presented challenges to both teachers and students (Korkmaz, 2020). It is important to know students' perceptions to provide information to administrators and educators in planning and designing their teaching and learning activities (Plat & Yu, 2014). In 2020, Abbasi *et al*. conducted a study and collected data from 382 students in a private medical college by using a 5-point Likert questionnaire to explore students' perceptions of e-learning during a lockdown. According to the data, most students had unfavourable

perceptions towards online learning. They concluded that students most preferred face-to-face learning compared to online learning. Giovannella (2020) conducted a study in Italy on students' perceptions towards transitions from face-to-face to virtual education. The study's findings revealed that although the students missed their usual face-to-face classes, they were able to adapt well to the abrupt change in learning environments.

Previous studies have presented valuable insights on students' perceptions and satisfaction with both face-to-face and online learning. Akuratiya & Meddage (2020) conducted a survey on IT students to examine the students' perception of online learning during the COVID-19 pandemic based on learning method, learning environment, and learning materials. According to the findings of this study, most students (80%) had a positive perception of online learning, while only a few (20%) had a negative perception of this online learning platform. Rawashde *et al* (2020) studied the transitioning from face-to-face to online learning based on students' perceptions of learning calculus. The findings showed that the students enjoyed their online learning time. It is because most of the students felt confident with the online platform and thought it was more interactive than face-to-face teaching. By considering the students' demographics and multiple content areas, Xu & Jaggars (2014) conducted a study to identify the performance gap between online and face-to-face learning in Mathematics. They found a substantial difference in the math results for online and face-to-face courses, with the online math course scores significantly (at a 1% significance level) below the face-to-face math course levels. According to this study, they reported that students had more difficulty succeeding in online courses compared to face-to-face courses.

The remainder of this paper is organized as follows: The study's methodology is covered in Section 2 of the paper. Results and discussion are further upon in Section 3. Section 4 provides a few conclusions for this study.

Methodology

This descriptive study employed a survey questionnaire to gather data. The survey uses dichotomous questions that ask for Yes or No response. The survey was conducted by distributing an online questionnaire through Google Form among undergraduate students of Universiti Teknologi MARA, Perak Branch, Tapah Campus during March – August 2022 semester. A sample consisting of 82 respondents from the Calculus courses were recruited as respondents in the present study using a simple random sampling method. After following 8 weeks of online lessons, a questionnaire form was distributed to the students. The research instrument is a questionnaire developed by the authors for this study and arranged into three parts. The first part of the survey covered four items related to respondents' demographic background (gender, age, race and placement). Second part contained ten items related to respondents' perceptions of online learning, in which related to the benefits, disadvantages and respondents' general perceptions of online learning. Meanwhile the final part of the survey covered ten items related to respondents' constraints of online learning. The responses from the questionnaire were entered in Microsoft Excel and analyzed using IBM Statistical Package for the Social Science 25.0 for descriptive analysis. All categorical variables were presented as frequencies and percentages. A correlation was analyzed using Chi-Square Test of Independence method to measure the strength and direction of the relationship between the two variables. The significance level was set as $\alpha = 0.05$. Through this method, if the P-value obtained is greater than the significance level, it proves that there is no correlation involved between the two variable factors, on the contrary, if the P-value obtained is less than

the significance level, it indicates that the two factors have a connection. Each data was classified into a nominal type and using the crosstab setting to get the result.

Results and Discussion

Table 1 summarizes the demographical characteristics of the respondents. Most of the respondents were female (74.39%), all are at the same age and same race. Slightly more than half of the studied sample (57.32%) placed at urban area during the online learning.

Table 1
Demographical, n = 82

Characteristics		n (%)
Gender	Male	21 (25.61)
	Female	61 (74.39)
Age	19	82 (100.00)
Race	Malay	82 (100.00)
	Other	0 (0.00)
Placement	Urban	47 (57.32)
	Rural	35 (42.68)

The first objective is to investigate whether the two-way communication between Calculus courses students and lecturer is going well during this online learning. Figure 1 below shows that half of the students initially had the perception that they would face two-way communication problem with the lecturer during online learning. However, the data in Figure 2 denies it when 68.3% of the 82 students, that is, 56 students indicated that they do not have any problem to communicate well with the lecturer. Therefore, it can be seen that the lecturer managed to handle teaching and learning process well throughout the online learning.

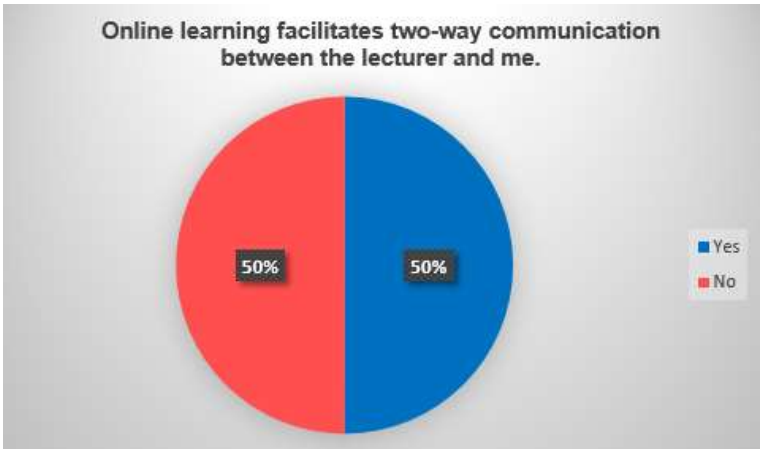

Figure 1: Respondents' perception related to two-way communication between students and lecturer.

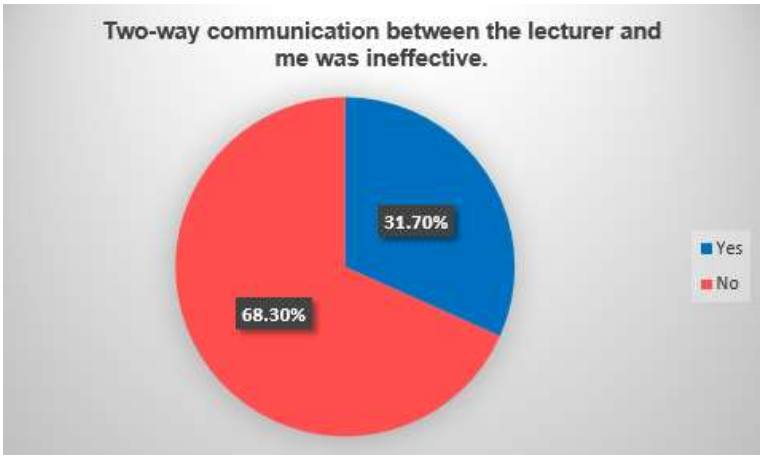

Figure 2: Two-way communication constraint between students and lecturer.

Next, the "Chi-Square Test of Independence" method was applied to study whether the problem of internet access is associated with the students' placement factor, whether non-conducive learning environment factor is linked to the factor of students' adaption to online learning, whether the discussion among students was difficult to carry out due to lack of facilities at home and last, whether students are uncomfortable doing presentations online related to the factor of students lacking confidence to turn on the camera. This test measures if two categorical variables are dependent on each other.

Based on Table 2, the number of students living in the urban areas (city) with poor internet access is 12 (25.5%) and without poor internet access is 35 (74.5%). Meanwhile, the number of students living in rural areas with poor internet access is 22 (62.9%) while 13 (37.1%) did not face this difficulty. From the table as well, it can also be seen that total number of students who have poor internet access at home whether they are from the city or countryside is 34 students (41.5%). Table 3 shows the test value for this analysis is 11.515 and the P-value is 0.001. Since the P-value is smaller than the significance level ($\alpha = 0.05$), it can be concluded that the placement factor is related to the poor internet access factor.

Table 2
Placement factor and poor internet access factor.

Placement * Poor_internet_access Crosstabulation					
			Poor_internet_access		
			Yes	No	Total
Placement	Urban	Count	12	35	47
		% within Placement	25.5%	74.5%	100.0%
		% within Poor_internet_access	35.3%	72.9%	57.3%
		% of Total	14.6%	42.7%	57.3%
	Rural	Count	22	13	35
		% within Placement	62.9%	37.1%	100.0%
		% within Poor_internet_access	64.7%	27.1%	42.7%
		% of Total	26.8%	15.9%	42.7%
Total		Count	34	48	82
		% within Placement	41.5%	58.5%	100.0%
		% within Poor_internet_access	100.0%	100.0%	100.0%
		% of Total	41.5%	58.5%	100.0%

Table 3
Chi-Square test for placement factor with poor internet access factor.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi_Square	11.515[a]	1	.001		
Continuity Correction[b]	10.029	1	.002		
Likelihood Ratio	11.693	1	.001		
Fisher's Exact Test				.001	.001
Linear-by-Linear Association	11.375	1	.001		
N of Valid Cases	82				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 14.51.
b. Computed only for a 2x2 table.

Table 4 presents the number of students with non-conducive learning environment and adaptive factor with online learning. 25 students (59.5%) with non-conducive learning environment faced difficulty to adapt online learning, while 17 students (40.5%) with non-conducive learning environment did not face this difficulty. Meanwhile for students with conducive learning environment, 11 students (27.5%) stated that they experienced difficulty of adapting to online learning while 29 students (72.5%) did not face this problem. From this table as well, it can also be seen that total number of students who had difficulty with the

adaption of online learning whether they are from conducive or non-conducive learning environment is 36 students (43.9%). Table 5 shows the test value for this analysis is 8.531 and the P-value is 0.003. Since the P-value is smaller than the significance level (α = 0.05), it can be concluded that non-conducive learning environment factor is related to students' adaption factor to online learning.

Table 4
Non-conducive learning environment factor and adaptive factor with online learning.

Non_condusive_learning_environment * Adaption_to_online_learning Crosstabulation					
			Adaption_to_online_learning		
			Difficult	Not Difficult	Total
Non_condusive_learning_environment	Yes	Count	25	17	42
		% within Non_condusive_learning_environment	59.5%	40.5%	100.0%
		% within Adaption_to_online_learning	69.4%	37.0%	51.2%
		% of Total	30.5%	20.7%	51.2%
	No	Count	11	29	40
		% within Non_condusive_learning_environment	27.5%	72.5%	100.0%
		% within Adaption_to_online_learning	30.6%	63.0%	48.8%
		% of Total	13.4%	35.4%	48.8%
Total		Count	36	46	82
		% within Non_condusive_learning_environment	43.9%	56.1%	100.0%
		% within Adaption_to_online_learning	100.0%	100.0%	100.0%
		% of Total	43.9%	56.1%	100.0%

Table 5
Chi-Square test for non-conducive learning environment factor with adaptive factor with online learning

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi_Square	8.531[a]	1	.003		
Continuity Correction[b]	7.280	1	.007		
Likelihood Ratio	8.709	1	.003		
Fisher's Exact Test				.004	.003
Linear-by-Linear Association	8.427	1	.004		
N of Valid Cases	82				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 17.56.
b. Computed only for a 2x2 table.

The other objective of this study is to investigate whether the discussion among students was difficult to carry out due to lack of facilities at home. Based on Table 6, total number of students who agrees that the group discussions are difficult to carry out due to lack of facilities at home is 14 (24.1%), while 44 students (75.9%) who faced difficulty to have group discussion disagree that lack of facilities at home is the real cause. The number of students who do not have problem to discuss in group via online but lack of facilities at home is only 1 (4.2%) while 23 students (95.8%) do not face this problem. Table 7 shows the test value for this analysis is 4.530 and the P-value is 0.033. Since the P-value is smaller than the significance level ($\alpha = 0.05$), it can be concluded that group discussions are difficult to carry out due to lack of facilities at home.

Table 6

Group discussions are difficult to be carried out factor with the lack of facilities at home factor.

Group_discussions_are_difficult_to_be_carried_out * Lack_of_facilities_at_home Crosstabulation					
			Lack_of_facilities_at_home		Total
			Yes	No	
Group_discussions_are_difficult_to_be_carried_out	Yes	Count	14	44	58
		% within Group_discussions_are_difficult_to_be_carried_out	24.1%	75.9%	100.0%
		% within Lack_of_facilities_at_home	93.3%	65.7%	70.7%
		% of Total	17.1%	53.7%	70.7%
	No	Count	1	23	24
		% within Group_discussions_are_difficult_to_be_carried_out	4.2%	95.8%	100.0%
		% within Lack_of_facilities_at_home	6.7%	34.3%	48.8%
		% of Total	1.2%	28.0%	29.3%
Total		Count	15	67	82
		% within Group_discussions_are_difficult_to_be_carried_out	18.3%	81.7%	100.0%
		% within Lack_of_facilities_at_home	100.0 %	100.0 %	100.0%
		% of Total	18.3%	81.7%	100.0%

Table 7

Chi-Square test for group discussions are difficult to be carried out factor with the lack of facilities at home factor.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi_Square	4.530[a]	1	.033		
Continuity Correction[b]	3.292	1	.070		
Likelihood Ratio	5.609	1	.018		
Fisher's Exact Test				.056	.027
Linear-by-Linear Association	4.475	1	.034		
N of Valid Cases	82				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.39.

b. Computed only for a 2x2 table.

The final objective for this study is to examine whether students are uncomfortable doing presentations online related to the factor of students lacking confidence to turn on the camera. Based on Table 8, total number of students who are not comfortable doing presentations because of lack of confidence to turn on the camera is 35 (92.1%), while 3 students (7.9%) are uncomfortable doing the presentation not because of they lack the confidence to turn on the camera. On the other hand, the total number of students who are comfortable doing presentations but having less confidence to turn on the camera is 32 (72.7%) and total number of students who are comfortable doing presentation while turning on the camera is 12 (27.3%). The Table 9 demonstrates the test value for this analysis is 5.123 and the P-value is 0.024. Since the P-value is smaller than the significance level ($\alpha = 0.05$), thus it can be concluded that students are not comfortable doing presentations online because they are less confident to turn on the camera.

Table 8
Students are not comfortable doing presentation factor with students lack confidence to turn on the camera factor.

Students_are_not_comfortable_doing_presentation * Students_lack_confidence_to_turn_on_the_camera Crosstabulation					
			Students_lack_confidence_to_turn_on_the_camera		Total
			Yes	No	
Students_are_not_comfortable_doing_presentation	Yes	Count	35	3	38
		% within Students_are_not_comfortable_doing_presentation	92.1%	7.9%	100.0%
		% within Students_lack_confidence_to_turn_on_the_camera	52.2%	20.0%	46.3%
		% of Total	42.7%	3.7%	46.3%
	No	Count	32	12	44
		% within Students_are_not_comfortable_doing_presentation	72.7%	27.3%	100.0%
		% within Students_lack_confidence_to_turn_on_the_camera	47.8%	80.0%	53.7%
		% of Total	39.0%	14.6%	53.7%
Total		Count	67	15	82
		% within Students_are_not_comfortable_doing_presentation	81.7%	18.3%	100.0%
		% within Students_lack_confidence_to_turn_on_the_camera	100.0%	100.0%	100.0%
		% of Total	81.7%	18.3%	100.0%

Table 9
Chi-Square test for students are not comfortable doing presentation factor with students lack confidence to turn on the camera factor.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi_Square	5.123[a]	1	.024		
Continuity Correction[b]	3.908	1	.048		
Likelihood Ratio	5.477	1	.019		
Fisher's Exact Test				.043	.022
Linear-by-Linear Association	5.060	1	.024		
N of Valid Cases	82				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.95.
b. Computed only for a 2x2 table.

The primary purpose of this study is to examine the perceptions of Calculus courses students and constraints that they faced regarding the online classes. Since early 2020, there are issues uprising when the classes need to be conducted online to cope up with the curriculum due to lockdown in the wake of COVID-19 pandemic. In order to probe into this matter, analysis of perceptions and constraints regarding online classes was required. The findings obtained through this present study were supported by previous studies. The study conducted by Rahim *et al* (2020) showed that the majority of participants concerns on the way online class being organized because of their perceptions towards online learning as well as the constraints that they faced which include online environment such as the location and environment of where they experienced their online learning. According to Muthuprasad *et al* (2021), the biggest challenge reported by the students was technological constraints such as lack of access to the internet. Online classes will be successful only if internet facility is provided to all by making it equitable and affordable. The concern over internet access especially in rural areas was also expressed by the students. It is challenging to build a comfortable environment for learning or a sense of community in the online environment. So here these two factors are related to each other. Petrides (2002) claimed that it was convenient to work in an online course in collaborative groups without rearranging the schedule for everyone as one would do in traditional classroom learning. However, they need convenient location to do that.

Based on the results of the study, it was obtained that some of the constraints of students towards online learning are related to each other. Therefore, this study agreed with previous studies that care should be taken to fix the online classes based on students' convenience, needs and constraints during online teaching and learning process.

Conclusion

Universities and institutions all over the world were shifting to online platforms to catch up with the curriculum since early 2020. How students will cope with online learning is depending on their perception and how they figure out the constraints besides the other factors as well.

The findings of this study indicated that majority of the students evinced a positive attitude towards online classes regarding two-way communication between them and the lecturer. Regardless of not having to see each other physically, their communication is going well. They also indicated that some of the constraints that they are facing are related to each other such as the problem of accessing internet factor was related to students' placement factor, the non-conducive learning environment factor was related to students' adaption to online learning factor, the difficulty of having group discussion factor was related to the lack of home facilities factor and lastly, the uncomfortable of doing presentation online was related to the factor of lacking confidence to switch on the camera.

Therefore, all these factors should be taken into consideration when conducting online classes to ensure that the class runs smoothly and that all students do not left behind in gaining knowledge. It will make online learning more effective and productive for students even though it is more challenging than the traditional classroom. It is possible that one day, even after COVID-19 pandemic settles down, we may see a continued increase in education systems using online platforms. Therefore, this study will be useful in designing online courses in the future when students' perceptions and constraints during online learning are taken into consideration.

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