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# Time to flip? Feedback from UNIMAS medical students towards implementation of flipped pathology classroom

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## ABSTRACT

This study aimed to explore the perception of year two preclinical medical students towards flipped classroom over conventional teaching method through qualitative and quantitative approaches. The study involved 110 year two preclinical medical students at the Faculty of Medicine and Health Sciences, Universiti Malaysia Sarawak from October 2020 to January 2021. Five one-hour pathology lectures were divided into two parts covering different topics of the lecture. The first half hour used conventional teaching, while the second half hour used flipped classroom. Student feedback was collected through a 19-item, self-administered questionnaire comprising 15 quantitative questions in 3 structured instruments and 4 qualitative open-ended questions. The score for mean perception of flipped classroom was significantly different according to place of residence while the mean knowledge acquisition score was significantly different among students using different internet sources. In addition, for examination preparation, slightly more than one third preferred traditional classroom. Six aspects of improvement on flipped classroom were identified: learning materials; teaching methods; quality of resource materials; class activity and interaction; choices of topics for flipped classroom; and time, pace, and atmosphere of lessons. Three aspects of significance of flipped classroom were captured, which included facilitating understanding and revision; flexible time, ability to ask and answer; and ability to share, focus and identify mistakes. A flipped classroom shows much potential in medical education. Future studies on feedback from students are needed to improve the flipped classroom to suit the Malaysian context.

**Keywords:** *Flipped Classroom, Traditional Classroom, Medical Student, Perception, Pathology*

## CORRESPONDING

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## INTRODUCTION

A flipped classroom pivots on the delivery of resources in various forms, either in audio, video, or print forms ahead of the scheduled teaching and learning session. This strategy allows teachers to spend their face-to-face time supporting students in deeper, more meaningful learning processes (1).

Students have been known to have issues retrieving abstract knowledge to solve problems when learning and context are separated (2,3). Professor Eric Mazur of Harvard University, a strong advocate of the flipped classroom, realised that lecturing was not effective in developing students' capacity to apply information (4). One of the suggested solutions is to create learning environments in which students deal with real-life problems using the previously acquired knowledge with the support of teachers as facilitators and advisers, thereby allowing students to work through the material before class at their own pace and view the material as often as they need. Teachers then help students apply the information which is a more difficult process when compared to processing basic information (1). In this setting, students are active learners receiving constant feedback based on their actual level of understanding (4,5).

The flipped classroom model has been described as particularly well suited for medical education, as the pre-class assignment can create a framework of core knowledge, and the active learning exercise can embed the knowledge through an interactive and engaging session (6). A meta-analysis showed that the flipped classroom approach improves performance among health professions students when compared to traditional teaching (7). Several recent independent studies among Malaysian students presented improvement in academic performance under flipped classroom (8,9).

### Student Perception Towards Flipped Classrooms

Flipped classrooms have received strong positive feedback from undergraduate medical students in both clinical and preclinical settings (10–12). Medical students express high degrees of satisfaction with online videos specifically designed for pre-class preparation in flipped classroom initiatives (13,14). One explanation for the more positive student perception is that having unrestricted access to pre-recorded video lectures before class enables students to learn anywhere and at any time (7). In addition, students have reported appreciation for concise, engaging, multimodal learning resources that can be accessed by students at their own pace (15). Furthermore, students also find re-watching videos and revisiting content particularly helpful along with the increased individual assistance that can be provided by the teacher, as well as learning with and from their peers (16). Lastly, the flipped classroom allows the student to take responsibility for his/her learning and the in-class active learning component of the flipped classrooms (17).

Despite students' favourable responses, the flipped classroom has its own challenges and issues. Certain aspects of the active learning components of their flipped medical education classrooms can be improved. This included some active learning activities, which are perceived to be inefficient, partly due to inadequate preparation by students (11). Students' resistance to the unfamiliar method is identified as a potential barrier to the flipped classroom model. Some students were accustomed to a more traditional lecture model and lacked experience with the flipped classroom model (18). Students also struggle with the inability to get immediate help or feedback since the learning process is conducted at home. Students who need help during out-of-class activities normally must take notes, write down questions, and wait for in-class discussions to obtain answers (19). Technical issues such as lack of internet access, lack of interest due to uninteresting online materials, resistance to technology and students feeling overwhelmed with new learning models have also been reported as challenges to the implementation of flipped classrooms (20). In this case, the needs of the students and facilities should be considered when planning future flipped classrooms.

In Malaysia, 19 studies have investigated flipped classrooms in other disciplines and students have good perceptions of flipped classrooms (21). However, a survey on Malaysian undergraduate pharmacy students' perceptions revealed contradictory findings, in which a low degree of acceptance and unfavourable impressions of flipped classrooms among students were reported (22). The reasons were identified to be the inappropriate use of the flipped methodology and the increased student workload. The main reason for the failure of flipped classroom among students appears to be inappropriate implementation as well as local learning culture in Malaysia. Instructors have burdened the students instead of engaging students' interest in learning.

Scientific literature that critically appraises the impact of flipped classrooms on clinical education and pathology teaching and learning is limited; thus, additional reliable research is required to establish solid evidence (23). In realising the study gap as well as the contradictory findings that were reported by Chan et al. (2020), further exploration is warranted. Therefore, this study aimed to explore the perception of year two preclinical medical students at UNIMAS towards the flipped classroom over conventional teaching method through qualitative approach and to determine the associated factors of perception and attitude of students towards flipped classroom method through quantitative approach.

## METHODS

### Study Design

The medical faculty follows problem-based, self-directed curricula, which are divided into academic blocks in the first two preclinical years and postings according to different disciplines in the latter three clinical years. Since the medical faculty's founding in 1994, all pathology lectures in the year two preclinical medical programme were delivered using a conventional lecture-based approach until 2018/2019, when flipped classrooms and case-based discussions were introduced by two of the pathology teaching staff members for the first time.

All the year two preclinical medical students of session 2020/2021 were invited to participate in this study. Students who did not agree to participate or had poor internet connection were excluded from this study. Throughout the project, most students remained in their hometowns due to the COVID-19 pandemic, while five students stayed on campus due to lack of or poor home internet connection. Classes were conducted online.

### Study Population and Sampling Method

This study included 147 year two preclinical medical students at the Faculty of Medicine and Health Sciences, UNIMAS from October 2020 to January 2021.

The calculation was derived from:

$$x = Z(c/100)2r(100-r)$$

$$N = N x / ((N-1)E^2 + x)$$

$$E = \text{Sqrt}[(N - n)x/n(N-1)]$$

given the sample size  $n$  and margin of error  $E$ .  $N$  is the population size,  $r$  is the fraction of response of interest and  $Z(c/100)$  is the critical value for the confidence level  $c$ .

This calculation was based on the normal distribution with more than 30 samples.

The minimum sample population with a margin of error of 5%, the confidence level of 95% for a population size of 147 and response distribution of 50% is 107.

## Procedures

The selected students were exposed to flipped classrooms and traditional classrooms in the MDP20109 Central Nervous System Block. Pathology sessions were conducted by four pathologists and included five one-hour pathology lectures on the central nervous response to injury, cerebrovascular diseases, tumours of the nervous system, demyelinating and degenerative diseases, and pathology of central nervous system infection. All four pathologists involved in the study are senior pathology lecturers, each with more than five years of teaching experience. Two of the four pathology teaching staff members individually conducted flipped classrooms before this study.

Each of the five one-hour pathology lectures were divided into two half-hour parts covering different topics under one learning unit. The first half hour's topic was delivered by conventional teaching, while the second half hour's topic was delivered by flipped classroom by the same lecturer. The resources for flipped and traditional classrooms were distributed via UNIMAS online learning management system at different times. For the flipped classroom, the printed and video resources along with case-based scenarios and questions were sent to the students one week in advance while the conventional teaching materials were distributed after the lectures. During the lecture's conventional teaching first session, each pathologist delivered the lecture didactically whereas during the lecture's flipped classroom second session, each pathologist went through the questions together with the students. Additional formative assessment activity using Kahoot was performed at the end of the teaching session.

## Data Collection

Student feedback was collected through a 19-item, self-administered questionnaire comprising 15 quantitative questions in 3 structured instruments and 4 qualitative open-ended questions adapted from Joshi et al (2017) and distributed to undergraduate UNIMAS students via Google Form at the end of the academic block.

The questionnaire was comprised of five components:

Quantitative component:

Part 1: Personal profile of the respondents

Part 2. Attitudes of students towards flipped classroom

Part 3. Perception of students on flipped classroom experience

Part 4. Role of flipped classroom in knowledge acquisition

Qualitative component:

Part 5: Students' opinion towards flipped classroom

## Personal Profile of the Respondents

For each respondent, gender, age of each respondent, ethnic group, place of residence, internet sources and electronic devices for teaching and learning data were gathered.

### **Students' Attitude Towards Flipped Classrooms**

Students responded to five items in a structured instrument related to flipped classrooms, including levels of engagement, willingness to recommend, time to communicate peers, enjoyment of watching lessons and ease of pacing. Responses to questions 1 to 5 were scored on a five-point Likert scale, such that 1 corresponded to 'Strongly disagree', while 5 corresponded to 'Strongly agree'. A mean score of the five items was calculated. A higher mean score indicated better attitudes towards flipped classroom implementation. The internal consistency of the instrument is appropriate with Cronbach's alpha at 0.725.

### **Students' Perception of Flipped Class Experience**

The third part of the questionnaire involved respondents' perceptions of flipped classroom and time spent learning via traditional method, preference for traditional versus flipped learning, and improvement of learning. The rating on each item was based on a five-point Likert scale. Responses to questions 6 to 9 were scored on a scale of 1 to 5, such that 1 corresponded to 'Strongly disagree', while 5 corresponded to 'Strongly agree'. A mean score of the four items was calculated. A higher mean score indicated better attitudes towards flipped classroom implementation. The internal consistency of the instrument is low, with the value for Cronbach's alpha at 0.256, which could be attributed to the instrument's limited number of components.

### **Flipped Classrooms and Knowledge Acquisition**

For the fourth part of the questionnaire, the students responded to seven items addressing review of resources, aid in case discussions, aid in discussion participation, improved understanding, more time to study, improved motivation, and improved exam preparation. Responses to questions 10 to 16 were scored on a scale of 1 to 5, such that 1 corresponded to 'Strongly disagree', while 5 corresponded to 'Strongly agree'. A mean score of the seven items was calculated. A higher mean score indicated better attitudes towards flipped classroom implementation. The internal consistency of the instrument was appropriate with Cronbach's alpha at 0.873.

### **Students' Opinions Towards Flipped Classroom**

The final component of the questionnaire consisted of four open-ended questions aimed at exploring opinions of the respondents on best teaching methods for examination preparation, implementation of the flipped classroom, the overall classroom, and the students' most significant learning experience during flipped classroom.

The questions included:

1. Choose and comment on the best teaching methods for examination preparation.
2. Please provide any other comments or suggestions to improve the implementation of the flipped classroom.
3. Please provide any other comments or suggestions to improve the implementation of the overall classroom.
4. Describe the most significant learning experience during the flipped classroom

## Ethical Consideration

Research ethical approval was obtained from the ethics committee of the Faculty of Medicine and Health Sciences of UNIMAS (UNIMAS FME/20/06). At the same time, informed consent forms were signed by the respondents before implementation of the project. All the information and data involving the respondents are confidential.

## Data Analysis

The quantitative information collected through the survey was analysed with IBM SPSS version 25 (IBM Corp., Armonk, NY, USA). Continuous data were presented in mean and standard deviation. Categorical data were displayed in count and proportion. Independent sample t-test and one-way ANOVA were used to determine the mean differences in the attitudes of students towards the conventional and flipped classroom, perception of students on conventional and flipped classroom experiences, and the role of conventional and flipped classrooms in knowledge acquisition among students according to different personal backgrounds. Findings were displayed within the table whenever applicable and the significant level was set at  $p < 0.05$ .

For the open-ended questions, thematic analysis was conducted using guidelines developed by Braun and Clarke (2006) (24). First, the researcher was required to review student feedback multiple times to become familiar with the data. Second, the coding process was started by using a highlighted pen. Identified codes were matched with data extracted from responses provided by students. Third, similar codes were categorised under their specific theme. Then, the relevancy of the data extracts within the identified themes was reviewed and refined. The extracts for each theme's data were further reviewed for consistency with the theme. During the process, the themes were reviewed either by combining two themes or separating a theme into two, based on their relevance. Finally, each theme received an appropriate name to reflect the contents for the report.

## RESULTS

The distribution of year two preclinical medical students is shown in Table 1. While in total, just 110 out of 147 students (72.1%) completed the survey, the response rates were more than adequate in the context of the given class size to draw useful conclusions. Out of these respondents, 74.5% were female, 46.5% were Malay and 44.5% were living in suburban areas. Most students used a laptop or personal computer for the classes with home internet as the internet source.

### Students' Attitude Towards Flipped Classroom

Students' attitudes are shown in Table 2. Approximately 51.8% found the flipped approach more engaging than traditional lectures, 31.8% were neutral and 16.3% did not agree that flipped learning was more engaging. Opinions were divided as to whether they would recommend the methods to their friends (38% undecided) and whether they have more time to communicate with their friends compared to traditional class. Most respondents agreed that they can pace themselves in the flipped learning approach (53.6%), and they liked watching the lessons on the video provided (60.0%).

### Students' Perception of Flipped Classrooms

Students' perception of flipped classrooms is shown in Table 3. More of the respondents were undecided (46.4%) or did not prefer flipped classroom in place of regular lectures (36.4%) for learning effectiveness. Many expressed that they spent more time in flipped classrooms compared to traditional lessons (40.0%). However, the majority of students liked self-pacing in flipped classroom (64.5%).

### Students' Perception on the Role of Flipped Classroom

Students' perceptions on the role of flipped classrooms are shown in Table 4. More students reviewed the resources regularly in the flipped classroom (62.8%) and agreed that flipped classrooms helped them to solve problems (53.6%), improved their understanding (50.9%), gave more time to study the topic (57.3%), and prepared them better for examination (57.2%). However, the opinion was mixed regarding which modality improved discussion and participation.

### Mean Difference in Perception and Attitude in Accordance with Socio-demographic Characteristics

Table 5 shows the mean differences in accordance with socio-demographic characteristics. There was a significant mean difference in perception between students from different place of residence ( $F = 4.181$ ,  $p = 0.018$ ). Bonferroni tests disclosed that greater number of students from rural areas had negative perceptions of flipped classrooms experience than urban (mean difference =  $-0.43$ ,  $p = 0.016$ ) and suburban (mean difference =  $-0.37$ ,  $p = 0.045$ ) students.

There was also a significant mean difference in perception of the role of flipped classrooms in acquisition of knowledge between students who use distinguishable internet sources ( $F = 5.339$ ,  $p = 0.005$ ). Bonferroni tests revealed differences between home internet-university internet (mean difference =  $1.08$ ,  $p = 0.007$ ) and with mobile internet-university internet (mean difference =  $1.15$ ,  $p = 0.005$ ).

There was no significant difference in attitude towards flipped classroom in terms of gender, ethnic groups, place of residence, device used, or internet source. There was only significant difference in student perception in terms of place of residence and only significant difference in knowledge acquisition involving internet source.

### Students' Opinion Towards Flipped Classroom

#### ***Best teaching methods for examination preparation***

In the survey, students were asked to comment on the best teaching methods for examination preparation. The majority preferred flipped classrooms. Comments from the student who preferred flipped classroom included:

*'Flipped classroom because from it I can understand better because it enhances my knowledge when discussing and I also can learn what question form that will be asked in the exam'.* (Informant 35)

*'Flipped classroom because I am able to implement my understanding of the lecture by answering the questions that was given and further understanding during the discussion'.* (Informant 68)

The comments from students who preferred conventional classroom included:



*'Conventional teaching is better for examination preparation since the lecturer can give clearer information compared to the students in flipped classroom'. (Informant 33)*

*'Conventional teachings, because it saves more time as the lecturer explain the information better rather than us reading by ourselves'. (Informant 57)*

One impartial response to both teaching methods stated:

*'Conventional teaching for better understanding but I think it is flipped classroom for examination preparation'. (Informant 85)*

## **Suggestions to Improve the Implementation of Flipped Classroom**

Students' comments about improving flipped classrooms and the overall classroom can be classified into six categories: a. learning materials, b. teaching methods, c. quality of resource material, d. class activity and interaction, e. topics, and f. time, pace and atmosphere of lessons.

### **Learning materials**

Distributing teaching material at least three days before the flipped session is important for the student to better prepare for the session.

*'By giving the case studies earlier (At least 3 days before) because since it is a new topic, I often have to take time to fully understand it before being able to answer the questions given confidently'. (Informant 68)*

*'Provide or upload all the notes needed before the discussion day'. (Informant 55)*

### **Teaching methods**

Students suggested more interaction, explanation and guidance during the session, especially in answering the questions, providing model answers, and going through the microscopic pictures.

*'I hope to have more guidance during flipped classes'. (Informant 94)*

*'For the microscopic images maybe, lecturer can explain more details regarding the finding since it is so hard to see the picture through the laptop screen'. (Informant 26)*

*'It is best for the lecturer to explain again after the student answer the question so the other students can clarify & understand better and clearer'. (Informant 33)*

*'I hope lecturer can use laser pointer more to locate any lesion or any abnormalities in microscopic and gross picture in pathology'. (Informant 100)*

*'We wish for answers being given during the discussion. First, students can confirm whether their answers are correct or not. Second, students will learn from the mistake they did'. (Informant 40)*

*'Clearer explanation on the topics'. (Informant 60)*

### **Quality of resource material**

The availability of better-quality resource materials, like video materials and lecture notes is also important.

*'For every lecture note if possible, prepare video for them as audio/visual learning will help us more to understand the topic better, after each lecture session prepare more quiz questions'*. (Informant 42)

*'Wish that every online flipped classroom has Kahoot quizzes or any other interactive quiz game'*. (Informant 107)

*'Please insert video teaching for the lecture, easier to repeat and rewatch videos for better understanding'*. (Informant 99)

*'More information on important parts can be put into the lecture notes'*. (Informant 53)

### **Class activity and interaction**

In addition to more student-lecturer interaction and live classes instead of pre-recorded session, students also suggested more variety of activities for student to be more proactive in the session.

*'Suggest more interaction activity with students'*. (Informant 8)

*'Live classes should be more often. Can interact better and have discussion'*. (Informant 59)

*'More online classes rather than pre-recorded lecture'*. (Informant 78)

*'It would be nice if there are questions (e.g.: case studies in pathology class) for other subject. It tests our understanding and helps us to clearly see the objectives of the lecture'*. (Informant 56)

### **Choices of topics for flipped classroom**

Students suggested that not all topics be flipped; both methods can be used with flipped classroom incorporated when the schedule is less packed. Since 40% of students responded that they spend more time in the flipped classroom than traditional classroom, one student suggested doing online classes only when necessary.

*'Not all lectures needed to be done in flipped classroom. Have a mix balance use of flipped and conventional classroom'*. (Informant 96)

*'I hope lecturers can approach both method'*. (Informant 105)

*'The flipped classroom sound exciting and I personally think it will help a lot of students study but the problem is if the schedule is jam packed it is not really that more efficient than normal conventional class because you basically have to sacrifice time need to spend on the other classes to do the activities need for flipped classes'*. (Informant 34)

*'I wish to have online class only when there is necessary because studying online makes us busier. We have more quizzes and exam that have to be done, same goes for others elective'*. (Informant 40)

### **Time, pace and atmosphere of lessons**

Students also suggested reduced time and slower pacing for lectures.

*'Reduce the duration of each lesson as using electronic gadgets are easier to get exhausted'.* (Informant 45)

*'Sometimes the explanation is very fast that the students missed it'.* (Informant 52)

*'I think it would be better to avoid from having 2 hours or more classes consecutively. I would appreciate if lecturers provided 10- or 15-minutes gap time between classes because it is so hard for me to keep focusing on the screen for too long'.* (Informant 39)

*'Give more time for us to read and understand the lecture notes and also do the case study'.* (Informant 27)

*'Overall atmosphere needs to be lightened so that students will be more comfortable in engaging in the discussion'.* (Informant 49)

## **Significance of Flipped Classroom**

### **Facilitate understanding, revision**

Some students found that flipped classroom helped them answer the questions, enhance understanding and memorisation and facilitate revision of the materials.

*'I can know how to identify the morphology and explain my answers'.* (Informant 101)

*'I can remember the concept easily as I need to truly understand the concept before answer the questions provided. It is help me to memorize the concept'.* (Informant 55)

*'I can enhance my understanding that I get from flipped classroom by discussing with lecturers and friends'.* (Informant 35)

*'I could revise the material many times and the recording made it easier for me to catch up on the important things of the lectures'.* (Informant 91)

### **Flexible time, ability to ask and answer**

Students found pre-recorded lectures, which can be reviewed and revised; time flexibility; ability to learn at their own pace; ability to ask questions; and the opportunity to learn more as helpful features. Some found the flipped classroom motivated them to join discussion.

*'Explanation is done based on the images showed during flipped classroom. All the pre-recorded lectures can be review back easily'.* (Informant 21)

*'Flipped classroom give me the time to answer the case study, if the traditional way, we tend to get blur during class. But the only problem happened is sometimes we have no time to answer the question before the class due to other commitments'.* (Informant 89)

*'Able to study at my own pace'.* (Informant 41)

*'I get to study at my own pace and be more motivated to answer the case study during discussion'.* (Informant 58)

*'Provide time for us to ask questions if there's any regarding the slides'.* (Informant 23)

*'It helps me to learn and explore more things'.* (Informant 60)

### **Ability to share, focus and identify mistake**

In addition, students liked the ability to share with others, focus on valuable information and identify their mistakes during discussions.

*'Students can share their answers freely and get feedback from lecturers'.* (Informant 40)

*'I can take note on the important information of the lecture'.* (Informant 87)

*'Get to know own mistake when discuss them'.* (Informant 107)

### **Setbacks**

A few setbacks during the session expressed by the students were:

*'The discussion will take long time if the questions need to be answer by volunteers'.* (Informant 44)

*'Most of the time I got frustrated and confuse when sudden connection loss happens especially during synchronous case study lesson'.* (Informant 46)

## **DISCUSSION**

Unlike previous studies in which most students had positive attitudes towards this mode of teaching and learning, the present study showed mixed responses, with slightly more than a third preferring traditional classrooms. Our students may require a gradual introduction to flipped classrooms over time or a hybrid of traditional lecture with flipped sessions. Therefore, some teacher-led instruction is still necessary, depending on the student's learning needs, best teaching method for selected topics and students' readiness for the flipped approach.

While studies have reported that students' engagement is higher in flipped classrooms compared to traditional classrooms (11), our findings were mixed. This was similar to another Malaysian study by Subramaniam and Muniandy (2019) where there was no significant difference in engagement levels (25). They hypothesised that a flipped approach suited interested students who had reviewed the materials prior to class and involved themselves in classroom activities while other students might feel more comfortable with the traditional approach. This may also explain our finding of mixed opinions when asked whether they would recommend the flipped classroom to their friends.

One of the key issues highlighted by our students relates to the perception that they spend more time in flipped classrooms. Time constraints are a common criticism of the flipped model even though flipped classrooms improve knowledge acquisition, retention, and integration (26). It is found that medical students spend significantly more time preparing for flipped classrooms than when they are in the traditional lecture-based classrooms (27). Related to the time constraint perception, our students suggested more time should be given to understanding the topic, while reducing the lesson time and slowing the explanation pace. Based on the Malaysian Medical Council, it is recommended the independent learning in flipped classrooms occupy a total of four hours with two hours for resource reviewing, one hour for answering questions, and one hour for face-to-face sessions (28). From the students' perspective, learning time for flipped classrooms is quite significant and should be managed

carefully (29). As the materials for the flipped classroom in this study are given a week before the session, preparation time for the students depends on their time management strategies, which may need to be addressed.

The main strength of a flipped classroom as reported in the literature is allowing students to go through the lecture content at their own pace (30). Many students regarded self-pacing as one of their favourite features. Our students also noted the resource videos and materials are helpful for preparation and understanding, similar to other studies (14). One study noted that video lessons improved understanding even though traditional teachers are relied on for clarification (31). The availability of unrestricted access to pre-recorded video lectures better enables the students to learn at their own pace which our students perceived positively.

Students who live in rural areas had a more negative perception of flipped classroom. In one study in Pakistan, urban medical students faced fewer problems with internet and electricity than rural students, and this could be an explanation for the negative perception within the rural subgroup (32). During the study, five out of the 110 respondents were living in the university residence due to the pandemic and, paradoxically, these students had a significantly negative perception of flipped classrooms. One possible explanation is that students who stayed alone during the pandemic had the highest anxiety levels as one study by Sundaresan et al (2020) reported. Even with better internet connectivity in the university residences, students who stayed alone were away from their loved ones which could make these students highly anxious and this pose challenges to learning (33).

The students also listed the significance of flipped classrooms which includes facilitating understanding, flexibility, ability to ask and answer questions, ability to share and have feedback, and ability to focus and identify mistake. This strongly highlights the fact that the flipped classroom approach induces self-directed learning, active learning and peer interaction among medical students. This is similar to other studies as reported in the systematic review by Ramnanan and Pound (2017). This learner-centred approach helps medical students independently facilitate their own learning and effectively interact with and learn from their peers and teachers (34).

Areas identified for improvements are the timely provision of resource materials and interaction activities between the lecturers and students. During this study, lecture materials for the traditional lectures were given after the lectures were delivered while the materials for the flipped session were made available a week before the session. Many students complained on this and suggested all the lecture materials be available before the sessions, whether for flipped or traditional. Our students also suggested more variety of interactive activities and for student to be more proactive in the session. As one study noted, the flipped classroom model cannot foster the positive learning experiences for which it is designed if students do not prepare for class, do not attend class, or do not engage while they are in class (35). Studies have shown the positive effect of engaging formative assessment like Kahoot! on learning performance and classroom dynamics, which could stimulate students' active participation and engagement (36).

Several limitations were identified in this study. First, student responses were based on their opinion, and as such there was a tendency that the responses might be influenced by socially desirable bias despite anonymity. Second, not all external confounding factors were included in the study especially regarding home environments such as availability of personal room, involvement in house chores, and any disturbance from surroundings that could influence learning progress of the students. Third, some instructors might lack experience since this was the first time that the entire pathology teaching staff participated in the flipped classrooms, and no formal training was provided. Fourth, the comparison of academic performance among students that followed flipped classroom and conventional teaching was impossible as both methods were used during the teaching of one specific topic.

## CONCLUSION

Flipped classrooms are accepted by the majority of medical students in learning pathology topics. The study findings could be a motivation and provide confidence for educators to introduce flipped classroom gradually in their lecture halls at medical schools in Malaysia. This is not only applicable to pathology but other medical topics such as physiology, anatomy, and even pharmacology. To better implement the flipped classroom especially in Malaysia context, more student input is needed. In this case, instructor training should be provided, especially related to teaching implementation (pace, duration, and interaction with students), preparation and administration of high-quality learning materials.

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**Table 1:** Demographic characteristics of the respondents (*N* = 110)

Demographic Characteristics	<i>n</i> (%)
Gender	
Female	82 (74.5)
Male	28 (25.5)
Ethnic group	
Chinese	21 (19.1)
Malay	51 (46.5)
Indian	5 (4.5)
Bumiputera Sarawak & Sabah	33 (30.0)
Place of residence	
Rural area	15 (13.6)
Suburban area	49 (44.5)
Urban area	46 (41.8)
Device used for flipped classroom	
Smartphone/Tablet	30 (27.3)
Laptop/Personal computer	80 (72.7)
Internet source	
Home internet	65 (59.1)
Mobile internet	40 (36.4)
University Wi-Fi	5 (4.5)



**Table 2:** Students' attitudes regarding the flipped learning approach ( $N = 110$ )

Item	Responses, $n$ (%)				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	1	2	3	4	5
This class is more engaging than the traditional class.	2 (1.8)	16 (14.5)	35 (31.8)	<b>44 (40.0)</b>	13 (11.8)
I recommend flipped class to my friends.	1 (0.9)	15 (13.6)	<b>42 (38.2)</b>	41 (37.3)	11 (10.0)
I have more time to communicate with friends than in the traditional class.	10 (9.1)	31 (28.2)	<b>34 (30.9)</b>	28 (25.5)	7 (6.4)
I like watching the lessons on video.	3 (2.7)	10 (9.1)	31 (28.2)	<b>43 (39.1)</b>	23 (20.9)
I find it easy to pace myself in flipped classroom than in the traditional class.	6 (5.5)	12 (10.9)	33 (30.0)	<b>34 (30.9)</b>	25 (22.7)
<b>Mean (SD)</b>					3.41 (0.70)

**Table 3:** Students' perception of the flipped learning approach ( $N = 110$ )

Item	Responses, $n$ (%)				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	1	2	3	4	5
I spend less time learning using traditional methods compared to the flipped classroom.	5 (4.5)	<b>39 (35.5)</b>	37 (33.6)	27 (24.5)	2 (1.8)
I prefer traditional teacher-led lessons.	0 (0)	30 (27.3)	<b>40 (36.4)</b>	23 (20.9)	17 (15.5)
I like self-pacing in the flipped classroom.	0 (0)	7 (6.4)	32 (29.1)	33 (30.0)	<b>38 (34.5)</b>
The flipped classroom has improved my learning compared to the traditional method.	1 (0.9)	12 (10.9)	<b>51 (46.4)</b>	34 (30.9)	12 (10.9)
<b>Mean (SD)</b>					3.31 (0.52)

**Table 4:** Students' perception of the role of flipped class in acquisition of knowledge (*N* = 110)

Item	Responses, <i>n</i> (%)				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	1	2	3	4	5
I review the given resources more regularly in a flipped classroom than the traditional class.	0 (0)	15 (13.6)	27 (24.5)	<b>41 (37.3)</b>	27 (24.5)
The flipped classroom helped me to solve the case discussion easily.	3 (2.7)	14 (12.7)	34 (30.9)	<b>44 (40.0)</b>	15 (13.6)
The flipped classroom has helped me to participate in the discussion better than the traditional class.	2 (1.8)	17 (15.5)	39 (35.5)	<b>40 (36.4)</b>	12 (10.9)
The flipped classroom has improved my understanding more than the traditional class.	1 (0.9)	19 (17.3)	34 (30.9)	<b>37 (33.6)</b>	19 (17.3)
The flipped classroom gives me more time to study the topic than the traditional class.	3 (2.7)	16 (14.5)	28 (25.5)	<b>40 (36.4)</b>	23 (20.9)
The flipped classroom gives me better motivation to study than the traditional class.	5 (4.5)	23 (20.9)	29 (26.4)	<b>36 (32.7)</b>	17 (15.5)
The flipped classroom prepares me better for the examination.	7 (6.4)	10 (9.1)	30 (27.3)	<b>38 (34.5)</b>	25 (22.7)
				<b>Mean (SD)</b>	3.51 (0.78)

**Table 5:** Mean differences in attitudes, perception, and knowledge acquisition with different characteristics among students (*N* = 110)

Variables	Mean (SD)	Mean Difference	T/F value	P-value
Attitude of students on flipped classroom				
Gender <sup>a</sup>		-0.09	-0.563	0.574
Male	3.34 (0.77)			
Female	3.43 (0.68)			
Ethnic groups <sup>b</sup>				
Chinese	3.47 (0.64)		0.750	0.475
Malay	3.47 (0.72)			
Others	3.29 (0.70)			
Place of residence <sup>b</sup>				
Rural area	3.20 (0.69)		0.852	0.430
Suburban area	3.47 (0.77)			
Urban area	3.41 (0.62)			
Devices used for flipped classroom <sup>a</sup>				
Smartphone/ Tablet	3.34 (0.67)	-0.09	-0.617	0.539
Laptop/Personal computer	3.43 (0.71)			
Internet source <sup>b</sup>				
Home internet	3.45 (0.72)		1.176	0.312
Mobile internet	3.39 (0.68)			
University Wi-Fi	2.96 (0.43)			
Perception of students on flipped classroom				
Gender <sup>a</sup>		-0.06	-0.510	0.611
Male	3.27 (0.48)			
Female	3.32 (0.54)			
Ethnic groups <sup>b</sup>				
Chinese	3.39 (0.57)		0.323	0.725
Malay	3.30 (0.52)			
Others	3.28 (0.51)			
Place of residence				
Rural area	2.97 (0.42)		4.181	0.018
Suburban area	3.34 (0.56)			
Urban area	3.40 (0.48)			
Rural - Suburban <sup>c</sup>		-0.37	0.045	
Rural - Urban <sup>c</sup>		-0.43	0.016	
Devices used for				
		-0.12	-1.217	0.228

flipped classroom <sup>a</sup>				
Smartphone/ Tablet	3.23 (0.41)			
Laptop/Personal computer	3.34 (0.56)			
Internet source <sup>b</sup>			0.623	0.538
Home internet	3.36 (0.55)			
Mobile internet	3.24 (0.48)			
University Wi-Fi	3.25 (0.43)			
Knowledge acquisition in flipped classroom				
Gender <sup>a</sup>		-0.18	-1.079	0.283
Male	3.38 (0.79)			
Female	3.56 (0.77)			
Ethnic groups <sup>b</sup>			1.060	0.350
Chinese	3.42 (0.76)			
Malay	3.63 (0.80)			
Others	3.41 (0.76)			
Place of residence <sup>b</sup>			1.638	0.199
Rural area	3.18 (0.93)			
Suburban area	3.55 (0.76)			
Urban area	3.58 (0.73)			
Devices used for flipped classroom <sup>a</sup>		0.21	0.364	0.719
Smartphone/ Tablet	3.57 (0.78)			
Laptop/Personal computer	3.36 (1.11)			
Internet source <sup>b</sup>			5.339	0.006
Home internet	3.53 (0.75)			
Mobile internet	3.61 (0.78)			
University Wi-Fi	2.46 (0.26)			
Home internet – University Wi-Fi <sup>e</sup>		1.08		0.007
Mobile internet- university Wi-Fi <sup>e</sup>		1.15		0.005

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Note:

a = independent sample *t*-test

b = ANOVA

c = significant differences in perception mean scores were found in rural-suburban and rural-urban.

d = significant differences in perception mean scores were found in students who used home internet-university WiFi

e = significant differences in knowledge mean scores were found in students who used mobile internet- university WiFi